TENDER NO: DMRC/ELECT./IT&PD/ILBS/HVAC-LV-FF/02

DELHI METRO RAIL CORPORATION LIMITED

(A Joint Venture of Govt. of INDIA & GNCTD)

TENDER DOCUMENT

FOR

HVAC , LV SYSTEM & FIRE FIGHTING WORKS

Of

Institute of Liver & Biliary Sciences (ILBS),Phase-2

D-1,Vasant Kunj ,Delhi-110070

Volume -2

SPECIAL SPECIFICATIONS

DELHI METRO RAIL CORPORATION LIMITED
Metro Bhawan , 13 , Fire Brigade Lane
Barakhamba Road , New Delhi-110001, India

TENDER NO: DMRC/ELECT./IT&PD/ILBS/HVAC-LV-FF/02

HVAC , LV SYSTEM & FIRE FIGHTING Works of

Institute of Liver & Biliary Sciences (ILBS) , Phase-2 at

ILBS,D-1,Vasant Kunj,Delhi-110070

SL. NO.	DESCRIPTION
	VOLUME – 1
1	Notice Inviting Tender
2	Instruction to Tenderers (Including Annexures)
3	Initial Filter (PQ)
4	Special Conditions of Contract
5	DMRC Labour Welfare Rules
	VOLUME – 2
1	Special Specifications
	VOLUME – 3 : NOT USED
	VOLUME – 4
1	Bill of Quantities
	VOLUME – 5
1	Tender Drawings
	VOLUME – 6
1	Condition of Contract of Safety , Health & Environment
2	General Conditions of Contract

SPECIAL SPECIFICATIONS

FOR

HVAC WORKS

INDEX

SR. NO.	DESCRIPTION	PAGE NO.
1	SCOPE OF WORK	2
2	CHILLERS	16
3	COOLING TOWER (Low Height F.R.P. INDUCED DRAFT MULTICELL TYPE)	26
4	HYDRONIC PUMPS	28
5	VARIABLE SPEED PUMPING SYSTEM SPECIFICATIONS FOR SECONDARY CHILLED WATER /HOT WATER APPLICATION	33
6	HYDRONIC PIPING	43
7	PIPE HANGERS	62
8	FLEXIBLE PIPE CONNECTORS	65
9	CLOSED PRESSURISED EXPANSION TANK	66
10	AUTOMATIC VACUUM DEGASSER FOR HEATING AND COOLING INSTALLATIONS	67
11	AIR & DIRT SEPERATOR	68
12	AIR MOVING EQUIPMENTS	69
13	VENTILATION FANS	80
14	SHEET METAL WORK	89
15	MOTORISED FIRE & SMOKE DAMPERS	101
16	FIRE DAMPER WITH FUSIBLE LINK AND SPRING TYPE MECHANISM	105
17	VOLUME FLOW LIMITER	106
18	SOUND ATTENUATORS	108
19	ULTRA VOILET GERMICIDAL IRRIDATION SYSTEM	109
20	NOISE AND VIBRATION CONTROL	111
21	THERMAL & ACOUSTIC INSULATION	114
22	PIPING INSULATION	116
23	CHEMICAL DOSING SYSTEM	120
24	ONLINE NON CHEMICAL WATER TREATMENT SYSTEM	125
25	HVAC ELECTRICAL SPECIFICATIONS	126
26	I.S. CODES	154
27	TECHNICAL DATA	156
28	LIST OF APPROVED MAKES	170
29	TESTING & COMMISSIONING OF HVAC	176
30	**SCOPE OF COMPREHENSIVE AMC of HVAC HIGH SIDE AND LOW SIDE (CHILLERS BY OEM ONLY)**	190

1.0 SCOPE OF WORK

Design, Engineering, Supply, Installation, Commissioning, Testing, Validation, Performance testing, Performance Guaranteeing and Providing warranty services for building services systems, sub systems, Equipments, assemblies and components covering mainly following discipline covered in the tender but not limited to:

- Air Conditioning Systems
- Ventilation Systems
- Pressurization
- Smoke Evacuation

Vibration Control, Seismic Isolation, Building with building, shrinkage and creepage control of services sub assemblies.
Building sustainability systems as inherent part of building services systems
Structural systems including foundations of equipments, support structure, sub support structure, structural penetration openings, making good of openings and finishing with basic building finishes materials.

02. Coordination with other contractors and nominated sub contractors employed by client to work in synchronization to achieve the project completion schedule.

03. To carry out the work as per the site quality assurance programmes, safety programmes and work surveying programmes laid by client.

04. To carry out the comprehensive annual maintenance contract of the plant after successful completion of defect liability period for a minimum period of five years.

DESIGN CRITERIA

1. The systems are conceptualized to cater air-conditioning needs with inherent features mentioned in subsequent Para's.

2. The systems provided for this project shall meet the following parameters while satisfying all local design weather conditions and code requirements.

   A. Cooling load Parameters : Basis of Design – Annexure – I

   B. Plant Working Cycle : 24 Hrs.

   C. Basement Ventilation : Normal & Fire mode

   D. Smoke Evacuation & Pressurization

   E. Toilet Ventilation

   F. Ventilation of Mechanical Areas

BASIS OF DESIGN – ANNEXURE – I

01.	Basis of Ambient Design Condition :	ISHRAE HVAC Data Book
02.	Ambient Design Condition :	DELHI Latitude-28.35°N Altitude- 216 Mts
	Summer :	DB 110°F / WB 75°F / RH 20% (DB 43.3°C / WB 23.9°C)
	Monsoon :	DB 95°F / WB 83°F / RH 60% (DB 35.0°C / WB 28.3°C)
	Winter :	DB 45°F / WB 41°F / RH 70% (DB 7.2°C /WB 5.0°C)
03.	Inside Conditions :	Academic - Comfort conditions Clinical - As per Ashrae Std /Hospital Consultant datasheet Vivarium - As per Ashrae Std /Hospital Consultant datasheet
04.	Lighting Load:	Academic - 1 watt/ sq.ft of floor area Clinical - 1 watt/ sq.ft of floor area Vivarium - 1 watt/ sq.ft of floor area
05.	Occupancy:	As per the Data sheet
06.	Equipment Load:	As per the Data sheet
07.	Minimum Nos. of Fresh Air Changes per hour:	Academic - As per Ashrae Std 62.1 Clinical - As per Ashrae Std 170 Vivarium - As per Ashrae Std 170
08.	Nos. of rows for chilled water coils :	100 % FA Rooms- 8 ROW COIL Comfort - 4 ROW COIL
09.	U values considered :	As per the details provided by architect- Exposed Walls: Average U-value - 0.10 Btu/hr ft2 °F Roof : U-value - 0.072 Btu/hr ft2 °F Glass : U-value : 0.28 Btu/hr ft2 °F SHGC : 0.20 Partition : Ceiling With Non Ac Area Above : 0.48 Floor With Non Ac Area Below : 0.48 Partition Wall : 0.40

COOLING LOAD:

Design Criteria as per ECBC / HOSPITAL recommendations has been taken into consideration for calculating the Peak Cooling load estimates for all areas.

Peak summer cooling Load for :

- Academic block – 300 TR
- Clinical block – 1260 TR
- Vivarium block – 450 TR

Diversified cooling Load to select chillers (Clinical + Vivarium) : 1482 TR
Academic & kitchen block will be served phase – I central plant

Peak winter heating load (Academic + Clinical + Vivarium) : 1500 KW

PROPOSED AIR-CONDITIONING SYSTEM:

The Diversified Cooling load works out to be 1482 TR

On the basis of the analysis of hourly load profile, following energy efficient option for Cooling system has been selected:

3 Nos. X 450 TR Water Cooled screw chillers + 3 Nos x 145 TR Air cooled Total Heat Recovery Heat pumps

PERFORMANCE REQUIREMENT

Contractor will be demonstrating the performance of HVAC systems meeting following criteria but not limited to:

01. Inside environmental conditions in terms of temperature, relative humidity and air distribution in conditioned area.
02. Inside Environmental conditions in terms of filtration and pollution control; CO2 and CO values
03. Noise Criteria
04. Equipment Performance in terms of capacity, flow, pressure, test pressure, pressure gradient, temperature gradient, sensible and latent heat recovery and scrubbing efficiency.
05. Equipment Energy performance
06. Hydraulic balancing
07. Thermal balancing
08. Vibration and seismic performance
09. Temperature Rise of fluid in insulated pipes, insulation performance
10. Calibration and Accuracy of instruments and controls
11. Integration of all equipments on BMS platform
12. Life safety equipment performance and integration with other life safety systems.
13. Electrical performance

PROJECT EXECUTION

In addition to compliance of General Conditions of the Contract (GCC) and Special Conditions of the Contract (SCC) requirements, the tenderer shall have to consider the following:

SUBMITTALS

A. DURING BIDDING

01. Bidder's confirmation as per the tender format.
02. Technical Data sheet of all Equipments and material as asked in tender supported by OEM's product data to include Mechanical, Electrical, Hydraulics, thermal, Aerodynamic and acoustic properties.

B. POST AWARD

01. Shop drawings in 1:100 scale for Each HVAC discipline to incorporate,
    The general arrangement of systems, sub systems, equipments, components and assemblies.
    Supporting arrangements to include hangers, seismic isolations, and vibration isolators.
    Foundation details Sectional elevations.
    Levels, insert levels and gradient
    Typical details.
    Blown up details.
    Construction joints.
    Wall and slabs penetrations, levels, sleeves, sealing mechanism, fire separation, fire integrity, fire stoppers and fire sealants.
    Equipments details containing key engineering performance parameters and equipment tagging
    System schematic drawings indicating riser arrangements, sizing on individual floors, tap-offs and system flow.

02. Isometric representations of piping schematic for key connection details.

Symbols and Legends

Coordinated HVAC construction drawings to incorporate;

The coordinated reflective ceiling plan showing locations of lighting fixtures, air outlet devices, sprinklers, detectors, speakers and other ceiling terminal devices.

The coordinated services plan showing services above ceiling to include HVAC duct work, water piping, drainage piping, sprinkler piping, bus trunking, cable trays, equipments, supports, hangers, surface mounted conduits, concealed conduits, above ceiling detectors, sprinklers, terminal devices with levels in plans and elevations incorporating all the disciplines in separate layers.

The coordinated services layout in floor screed, vertical walls and partition to show routing and constructability.

The coordinated HVAC services plan showing openings, chase and penetrations in walls and slabs in plans and elevations indicating the opening/sleeve sizes, levels with dimensions indication from column and beams.

The coordinated HVAC services plan on Architectural plot layout to show the battery limits and termination points of public utilities provided by infrastructure provider.

03. Product data sheets incorporating the physical, mechanical, electrical, thermal, hydraulic, aerodynamic, chemical and acoustic properties substantiated by OEM's catalogue, equipment computerised selection, performance curves, characteristics curves and relevant standards.

04. Product /Material certifications from relevant authorities, manufacturers, testing labs etc as and where required as per the tender specifications.

05. Calculations to substantiate the design and engineering intent to meet the performance requirement for all mechanical, electrical, hydraulics, seismic, vibration, thermal, acoustic and structural considerations. Such Calculations, if required and insisted upon by client/Consultant, shall be carried out by independent experts to be hired by contractor without any extra cost to client.

06. Computerised Fluid Dynamics simulations to ascertain engineered solutions e.g hydraulic balancing, thermal comfort, car parking ventilation, lightening protection etc, to be carried out by contractor as required or insisted by consultant/client.

07. Revised Bill of Quantities based on the shop drawings and statement of variation to be pre approved before execution or commencement of any work beyond the tender quantities and rates.

08. OEM's QAP to indicate the quality check at manufacturer's works.

09. Manufacturer's shop testing procedure as per the relevant standards for the equipments wherever required.

10. Lifting, access and maintenance strategy for all equipments.

11. Sample board at site to include all the materials for which data sheets can't be approved or can't be submitted. Physical sample of all materials required for aesthetic and visual approvals.

12. The Contractor shall submit detailed schedules showing the program and the sequence in which the Contractor proposes to carry out the work with dates and estimated completion times for various parts of the work. Such schedules shall be approved by the client before starting the work and shall be binding on the Contractor. If so required by the client, the Contractor shall furnish weekly progress reports.

13. Installation procedures with site QAP indicating material handling, storage, installation methodology, inspection stages, pre commissioning checks, commissioning, testing and validation procedure for each system, subsystem and equipment.

14. Routine, type and specific test reports for the equipments and materials wherever required.

15. AS BUILT DRAWINGS in all the format of shop drawings including coordinated 2D and 3D drawings.

16. Internal Installation check and completion certificates.

17. Pre commissioning procedures

18. Pre Commissioning results

19. Certification of punch list attendance.

20. Commissioning and testing Procedures

21. Commissioning and testing results.

22. System validation report

23. Seasonal test reports during defect liability period

24. Warranty certificates from OEM.

25. Operation and maintenance manuals.

26. List of recommended & mandatory spares and consumables.

QUALITY ASSURANCE

INTENT OF DRAWINGS

A. Provide complete and functional systems for the project. The systems shall confirm to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and confirm to accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this contractors work.

B. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, valves, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Install systems in such a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the owner.

C. These documents may not explicitly disclose final details required for a complete systems installation; however, contractors shall possess the expertise to include the necessary appointments of complete operating systems.

D. Contractors shall be “Experienced” in this type of construction and realize the extent of the work required.

PRE-BID SITE VISIT

Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions. To schedule a site visit, contact client’s representative at least 48 hours in advance of desired time of visit.

GENERAL STANDARDS OF MATERIALS

Equipment and materials, unless otherwise noted, shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five years.

Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.

Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.

With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

PRODUCTS AND SUBSTITUTIONS

Where a specific manufacturer's product is specified, the contract sum shall be based on that product only. Any substitutions from the specified product shall be offered as a Substitution Request. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

Where several manufacturers' products are specified, the Contract Amount shall be based upon the specified products only. Any substitutions from the specified products shall be offered as a Substitution Request. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturers' products are specified, the associated systems have been designed on the basis of the first named manufacturer's product. When products other than those used as the basis of design are submitted, the contractor shall agree to accept a unilateral change order that includes additional costs incurred by the Owner for the consultant's review of submissions, redesign, and system and/or structure modifications required by the use of that product.

It is the intent of these specifications that service organizations such as balancing agencies follow the above substitution procedures.

APPLICABLE CODES

Materials furnished and work installed shall comply with applicable codes listed, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.

WATERPROOFING

Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

ELECTRICAL CONNECTIONS

Regardless of voltage, provide control wiring, interlock wiring, and equipment control wiring for the equipment provided under this division of the specifications.

Furnish electrical disconnect switches, starters and combination starter disconnects required for equipment provided under this division of the specifications. Circuit breakers furnished shall be rated for motor protection.

Power wiring not used for control functions, complete from power source to motor or equipment junction box, including power wiring through starters, shall be provided as per electrical work specification of the tender.

Coordinate to ensure that electrical devices furnished or provided are compatible with the electrical systems used.

EQUIPMENT FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

Provide necessary foundations, auxiliary steel, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal requirements prior to the purchase, fabrication or construction of same.

Provide adequately thick concrete pads for boilers, chillers, compressors, base-mounted pumps, rotating equipment, and floor-mounted equipment located in equipment rooms and as indicated on drawings. Pads shall be extended 6 inches beyond machine base in each direction with top edge chamfered. Anchor equipment pads to the floor in accordance with latest building codes seismic requirements.

Construction of foundations, supports, and pads where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding floor material.

Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Consultant, deemed insufficient shall be replaced as directed, with no additional cost to the Owner.

EQUIPMENT GUARDS AND RAILS

Provide readily removable guards or railings for belt drives and rotating machinery. Guards shall consist of heavy angle iron frames, hinged and latched, with heavy galvanized iron crimped mesh wire securely fastened to frames. Railing shall be 1-1/2 inch pipe and railing fittings.

Multiple V-belt drives shall have band belts to minimize vibration.

CLEANING, PROTECTION AND ADJUSTMENT

Cleaning:

Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.

Protection of Surfaces:

Protect new and existing surfaces from damage during the construction period.

Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.

Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Consultant

Protection of Services:

Protect new and existing services from damage during the construction period.

Repair, replace and maintain in service any new or existing utilities, facilities or services (underground, Over ground, interior or exterior) damaged, broken or otherwise rendered inoperative during the course of construction.

Services damaged during the construction shall be replaced at the cost of the Contractor at fault. The method used in repairing, replacing or maintaining the services shall be approved by the Owner and Consultant.

The Contractor shall make good all damages to the Purchaser's building, property, equipments and articles, how so ever arising from the erection of the equipment. The Contractor shall indemnify and hold harmless the employer against all claims in respect of injury to any person how so ever arising out of the erection of the equipment in the course of such installation.

During erection the Contractor shall at all times keep the working and storage areas free from waste or rubbish. On time-to-time, as directed by Employer in charge, he shall remove all temporary structures, debris, insulation bitumen, EPS wastage and leave the premises neat and clean in a satisfactory condition.

All equipment shall be complete with approved safety devices wherever a potential hazard to personnel exists and with provision for safe access of personnel to and around equipment for operational and maintenance functions.

These items shall include not only those usually furnished with elements of machinery but also covers, guards, crossovers, stair ways, ladders, platforms, handrails etc. which are necessary for safe operation of the system. The contractor shall include for all safety devices including but not limited to the following items-

a. Belt Guards shall be designed with approved provision to facilitate belt inspection, adjustment, replacement and general servicing.

b. All couplings are to be covered with an approved guard, fabricated from welded plate and structural steel.

c. Access Ladders and Platforms

Protection of Equipment and Materials:

Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground and out of standing water by means of pallets or racks, and covered with tarpaulins.

Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Consultant or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.

The contractor shall make his own arrangements for the storage of materials & their safe custody at site.

During the construction period, protect ductwork, piping and equipment from damage and dirt. Properly cap ductwork and piping. Each system of piping shall be flushed to remove grit, dirt, sand, and other foreign matter for as long a time as required to thoroughly clean the systems.

Provide two (2) complete sets of filters. One set shall be installed just prior to balancing but after cleaning of duct and air handling systems. The second set of filters shall be turned over to Owner for future use. Exception: for HEPA filters, provide only one (1) complete set. HEPA filters shall not be installed until system is turned over to Owner.

Should air handling systems be used for temporary cooling during construction, provide temporary filters of equivalent efficiencies to those specified in addition to the two (2) permanent sets required above. Temporary filters shall be replaced with additional temporary filters, as required, when the pressure drop is double the initial pressure drop rating of the filter.

ACCESSIBILITY

A. Coordinate to ensure the sufficiency of the size of shafts, and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.

B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, speakers, etc. Equipment requiring access shall include, but is not necessarily limited to, valves, traps, clean-outs, motors, fire dampers, controllers, switchgear, drain points, etc.

C. Furnish access doors under this division for installation by General Contractor. Coordinate during bidding phase with General Contractor.

D. Indicate the locations of access doors for each concealed valve, control, damper, or other device concealed behind finished construction and requiring service on the coordination drawings. Equipment below floor slab or finished grade shall be also be indicated on the coordinating drawings.

PAINTING

Painting requirements of this section shall confirm to relevant standards.

Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.

Provide field painting of all piping, ductwork, hangers, supports, equipment platforms, railings, and miscellaneous metals located outdoors (including galvanized jacketed piping, galvanized jacketed ductwork, insulated ductwork, and insulated piping). Piping over 200 deg. F shall be finished with high temperature epoxy paint. Application shall be in strict accordance with manufacturer's recommendations.

Provide painting of mechanical items exposed in mechanical equipment room and in occupied spaces.

SITE ACCOMODATION

The Contractor shall make his own arrangements for providing accommodation for his workmen at site.

WORKMEN PERMIT

The Contractor shall discharge all his obligations under the Indian Workman’s Compensation Act & E.S.I. in so far as it affects workmen in his employment.

The Contractor shall make his own arrangements for procuring the necessary labour, skilled and unskilled. He should conform to all local government laws and regulations concerning labour and their employment.

The contractor and his employees will submit to the regulations in force for controlled entry into the premises where the air conditioning equipment is to be installed.

Provisions shall be made for access ladders and platforms with handrails as necessary to provide operator's safe access to inspection.

Access to the work shall be allowed only to the Contractor and his duly appointed representatives. The Contractor shall not object to the execution of work by other Contractors or tradesman and shall afford them every facility for execution of their works simultaneously with his own.

Work shall be carried out in conformation with the specifications, accompanying drawings and with the requirements of the general architectural and structural plans after approval by the Employer. The Contractor shall be responsible for taking actual measurements at site and effecting variations in the work in details, if required, to meet the site conditions. Such deviations shall however be subject to the approval of the Employer.

CO-OPERATION

The Contractor shall also co-operate with other Contractors employed by employer, compare plans, specification & time schedules & shall forward to the Employer copies of all correspondence & drawings so exchanged. Failure to check plans and conditions will render the Contractor responsible for bearing the cost of any subsequent change.

NEGLIGENCE

If the Contractor shall neglect to execute the work with the due diligence or shall contravene the provisions of the contract, the Employer may give notice in writing to the Contractor, calling upon him to make good the neglect or contravention complained of. If the Contractor fails to comply with such notice within a reasonable period, the Employer shall have the option and be at liberty to determine the contract and to take the work wholly or in part out of the Contractor's hands and complete it either by himself or his agents at a reasonable price. The Employer shall then be entitled to retain any balance payment which may otherwise be then due on the contract.

The cost of execution of such work as aforesaid will be adjusted against the payment due to the Contractor. If the cost of execution shall exceed the balance due to the Contractor, the Employer shall be at liberty to dispose off any of the Contractor's material or construction system that may be at site and apply the proceeds for payment of the difference of such cost and recover the balance by process of law, or from any moneys due to the Contractor.

INSPECTION

The Employer is at liberty to inspect the system during installation and the Contractor free of cost shall remedy defects found. The Contractor shall furnish all instruments and services needed for the tests. Any defects and deficiencies that are noticed during these inspections will have to be attended by the Contractor from time to time.

Only after the entire installations are satisfactorily completed and the defects found during inspections rectified, the system will be ready for commissioning and then will be subjected to run at least 48 hours to demonstrate its satisfactory performance.

The contractor shall undertake to extend free training in operation and maintenance of Air conditioning System offered by them to two technical persons of Client/ End users at their works for a period of 15 days and 15 days at the site of Employer. A certificate in this regard will have to be obtained from the Employer by the contractor. The expenditure in respect of journey and stay necessary for this training will be borne by the contractor. The choice of dates for training is to be decided in consultation with the Employer.

1. Piping, pipe hangers, pipe insulation, and supports
2. Ductwork, duct insulation.
3. Mechanical equipment, and supports.
4. Heat exchangers.
5. Tanks.
6. Accessory items.

WARRANTY SERVICES

The Contractor shall guarantee that all material, machinery, Consumables and components, supplied, fabricated, designed and installed by him shall be free from defects due to faulty material and/or workmanship and that the system shall perform satisfactorily, and the efficiency of the system and all the components shall not be less than the values laid down in the specifications and the capacities shall be at least equal to those specified. The period of the guarantee shall be **twenty four (24) months** from the date of commissioning or one month after the successful final test whichever is later, during which period any or all components found to be defective shall be replaced or repaired free of charge and shortcoming found in the system as specified shall be removed at no extra cost. The Contractor shall make good any loss of refrigerant and oil at his own cost. The Contractor shall provide the necessary personnel and tools for fulfilling the guarantee.

If the defects are not remedied within a reasonable time, the Client may proceed to get the defects remedied at the Contractor's risk & expenses without prejudices to his right.

The Contractor shall without any cost to the Employer carry out during the guarantee period all routine and special maintenance of the system and attend to any defects that may arise in the operation of the system

BIDDER'S CONFIRMATION

The Bidder shall submit his confirmation with offer as under on a Legal Stamp Paper valid until end of the guarantee period.

01. We confirm that tender package comprising of tender documents volume 1 and volume 2, drawings and relevant documents have been thoroughly studied and verified by us. We confirm that design of HVAC systems outlined by above documents and drawings meets the performance requirement of various sub systems, equipments and components as specified in the tender documents and drawings. In our opinion, the design outlined in the tender documents is the most economical and energy efficient to achieve the building services performance requirements

which we are guaranteeing.

02. We confirm that we have visited the site and are well aware of site conditions and status. We confirm that site location, layout and conditions are suitable for executing the MEP services work outlined in the tender and has no bearing on completion period specified in the tender.

03. We confirm that the design on which this tender is prepared has been verified by us and that it meets with the requirements of all Government, Semi-Government, Municipal, local and other authorities, whose permission would become necessary for the completion of the project. We confirm that all such necessary approvals will be obtained by us without any extra cost to client.

04. We confirm that the design outlined in the tender meets all safety standards and services built in eventually shall be suitable for public from all walks of life and will not create any hazard.

05. We confirm that the design outlined in the tender meets all life safety requirements expected out of MEP and Life safety services in accordance with the latest global standards and practices. We also confirm that life safety systems specified in the tender supports the performance based fire engineering approach for the issues not explicitly specified in the standards.

06. We confirm that we have studied the drawings furnished along with the tenders and all equipments layouts shown in the drawings are meeting the requirement of installation, access, removal and maintenance of all systems, sub systems, equipments and components. We confirm that proposed layouts indicated in the tender also suit the requirement of man power access to all equipments for necessary maintenance and handling.

07. We confirm that we have studied the point matrix furnished under the heading of “sustainability”. We confirm that design, equipment specifications, Performance requirements and item listed in the BOQ meet the expected point matrix projection.

08. We confirm that we have understood the intent of project building services requirement and all necessary computerized simulation studies, analysis, software programming, graphic developments and hiring expert services to substantiate the design will be provided by us without any additional cost as required by client/ Consultants.

9. We have reviewed the list of approved makes and confirm to adhere to it during entire contract period. We also confirm that makes specified in the tender has no bearing on completion period.

10. We confirm that there shall not be any deviation to tender terms and conditions.

2.0 CHILLERS

2.1 WATER COOLED SCREW CHILLER

GENERAL –

UNIT DESCRIPTION

Supply, install, test and commission of 450 TR water-cooled Screw packaged chiller. Each unit shall be complete with **minimum two Semi hermetic** Screw compressor with lubrication and control system, evaporator, condenser, refrigerant control device and any other components necessary for a complete and operable chiller package.

DESIGN REQUIREMENTS

A. General: Provide a complete water-cooled semi hermetic screw compressor water chilling package as specified herein. In general, unit shall consist of a compressor, condenser, evaporator, lubrication system, starter and control system. Chillers shall be charged with an environmentally safe Non CFC, Non HCFC refrigerant such as HFC-134a refrigerant, which will meet the requirements of the Montreal Protocol and not having any phase-out schedule. Chillers should work only on positive pressure refrigerant. Chillers working under negative pressure and those requiring purge unit for maintaining negative pressure inside the unit are not acceptable.

Performance: The chiller shall be capable of stable operation to 20% percent of full load with standard ARI entering condenser water relief without the use of hot gas bypass. Acoustics: Sound pressure levels for the complete unit shall not exceed 85 dBA. If sound levels exceed 85 dBA then, provide the necessary acoustic treatment to chiller as required so as to limit the sound to 85 dBA.

PRODUCT COMPONENTS

COMPRESSOR:

a. Unit shall have minimum two semi hermetic screw compressors with twin screw rotors. Thrust bearings are accessible for maintenance and replacement. The lubrication system shall have an emergency system to protect machine during coast down period resulting from power failure.

b. The impeller shall be statically and dynamically balanced. The compressor vibration level shall not exceed a level of 0.14 IPS (inch per second).

Unloading shall be accomplished by movable inlet guide vanes actuated by an internal oil pressure driven piston and regulating speed of motor. Compressors using an unloading system that requires penetrations through the compressor housing or linkages, or both that must be lubricated and adjusted are acceptable provided the manufacturer provides a five-year inspection agreement consisting of semi-annual inspection, lubrication, and annual change out of any compressor seals. A statement of inclusion must accompany the offer.

LUBRICATION SYSTEM:

The compressor shall have an independent lubrication system to provide lubrication to all parts requiring oil. Provide a heater in the oil sump to maintain oil at sufficient temperature to minimize affinity of refrigerant, and a thermostatically controlled water-cooled oil cooler. Coolers located

inside the evaporator or condenser are not acceptable due to inaccessibility. A positive displacement submerged oil pump shall be powered through the unit control transformer.

REFRIGERANT EVAPORATOR AND CONDENSER:

1. Evaporator and condenser shall be of the shell-and-tube type, designed and constructed, according to the requirements of the ASME Section VIII / GB Code. Provide intermediate tube supports at a maximum of 500 mm spacing.
2. Tubes shall be enhanced externally as well as internally for maximum heat transfer, rolled into steel tubes sheets and sealed with Locktite or equal sealer. The tubes shall be individually replaceable. The evaporator tubes should be minimum 24 G and condenser tubes should be minimum 24 G thick at the root of the fins.
3. Provide isolation valves and sufficient volume to hold the full refrigerant charge in the condenser during servicing.
4. The water sides shall be designed for a minimum of 20.6 kg/cm2 or as specified elsewhere. Vents and drains shall be provided.
5. For chilled water selections the minimum refrigerant temperature permissible and acceptable shall be 33°F.
6. Refrigerant flow to the evaporator shall be controlled by a self-metering and adjustable thermal expansion valve. The liquid line shall have a moisture indicating sight glass.
7. The evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable because of the possibility of internal leaks.
8. Reseating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.
9. The evaporator, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

Provide factory mounted and wired water pressure differential switches / flow sensors on each vessel to act as flow switches and prevent unit operation with no flow.

PRIME MOVER:

Squirrel cage induction motor of the hermetic type of sufficient size to efficiently fulfill compressor Horsepower requirements. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with the starting method specified. Power Supply for the motor shall be as specified.

COMPRESSOR MOTOR STARTER

The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

The starter for the motor shall be automatic Soft starter type with tappings to limit starting current, within 3 times the full load current.

The motor starter shall be factory mounted and fully wired and factory tested, during running test of the unit.

The starter should be housed in a separate, unit mounted / floor mounted housing and include all necessary safety devices:

Door interlocked circuit breaker capable of being padlocked.
UL listed ground fault protection.
Over voltage and under voltage protection.
3-phase sensing motor over current protection.
Single phase protection.
Insensitive to phase rotation.
Over temperature protection.

The offered Chiller should be compatible for the following specification.

Cooling Capacity	: 450TR
Chilled water inlet/outlet temp	: 11/6 C
Fouling factor	: 0.000018 M^2 K/W
Condenser water inlet/outlet temp.	: 32/36 C
Fouling factor	: 0.000044 M^2 K/W
Minimum COP at ARI Condition	: 5.75

Chiller should be ARI or Eurovent certified for 50Hz operation.

2.2 MULTI PURPOSE CHILLER

Chillers should be of High efficiency series with elevated total efficiency rates (TER). **The chiller should be capable of working at Cooling Mode to generate only cooling, Heating mode to generate only heating and both cooling and Heating Mode to generate cooling and heating simultaneously.**

The chillers should have auto defrosting system that is able to optimize the defrosting time with improvement of the total efficiency.

.

Multi-purpose units should work with automatic mode switch suitable for outdoor installation on four-pipe plants with capability to work also with a 2 pipe system or with separate 4/2 pipe cooling/heating , and separate 2 pipe heating system. The unit should be supplied with anti-freeze oil and refrigerant and has been factory tested. On-site installation will just involve making connections to the mains power and water supplies. Unit should be factory charged with R410a / 407c / 134a refrigerant.

UNIT COMPOSITION

Supporting frame should have base and frame in thick hot-galvanised shaped sheet steel. All parts should be polyesters-painted.

Compressor

Semi-hermetic screw compressors should be designed for high efficiency both at full and partial load. The bearings should be provided along the rotor axis in a separate chamber isolated from the compression chamber are made in carbon steel. Each compressor should have provided with an inlet for refrigerant injection (for the extension of operating limits) and the use of the economiser (for the output capacity and efficiency´s increase). Each compressor should be fitted with manual-reset motor thermal protection. A check valve should be fitted on the refrigerant delivery line to prevent the rotors from reversing after stopping.

PRODUCTION OF JUST CHILLED WATER

The unit should work like a simple chiller and therefore discharges the excess heat from inside the building (condensation heat) to the atmosphere through the Air finned tube heat exchanger.

The water is cooled in a water shell and tube heat exchanger. (Evaporator).

PRODUCTION OF JUST HOT WATER

In this case, the unit should work exactly like a heat pump which channels the heat of the external atmosphere through an Air finned coil (evaporator) in order to heat the water sent to the inside of the building through a water shell and tube heat exchanger (condenser). The hot water should be produced in a heat exchanger (called a heat recovery shell and tube exchanger) and not a shell and tube evaporator. This is necessary in order to keep the hot and cold sections separate as required by a four-tube systems.

COMBINED PRODUCTION OF HOT AND CHILLED WATER

The unit should be capable of providing Hot & Cold water SIMULTANEOUSLY in any proportion, irrespective of the individual Heating & Cooling load at any given point of time. If the user's

requires the hot and chilled water at the same time, the unit should behave just like a chiller with total condensation heat recovery. The condensation heat is recovered in a water shell and tube heat exchanger (heat recovery exchanger) in order to heat the water for hot water users. The refrigerant evaporates in another water shell and tube heat exchanger (evaporator) and cools the water in order to satisfy requests for cold water. In addition, the Unit should have an Auxillary Air Based Heat Exchanger, to balance the load demand between Hot & Cold water. When the Hot water demand is higher, the Auxillary Air based heat exchanger will balance the load by behaving like an evaporater, and drawing the necessary evaporation heat from the atmosphere, to balance the System. When the cooling demand is higher than Heating demand, the Auxillary Heat exchanger will act as a condenser, At this point, it will reject the excess heat into the atmosphere.

The whole System shall be auto-adaptive, with programmed algorithms capable of automatically judging the demand for Hot & Cold water based on sensing of supply / return water temperature both on hot & cold side

The multi-purpose unit should be designed to distribute total power output (hot and cold) over various independent cooling circuits (up to a minimum of 2 for each unit). The microprocessor control on the unit, should optimise variations in this solution with internal requirements by adopting the operating configuration it considers to be most suitable for each cooling circuit. The use of suitable thermal accumulations, both on the cold and hot sides is required, for effective system operating modularity and to optimise running costs.

Cooling Capacity at Heat Recovery Mode : 145TR +/- 2.5% @ 35°C
Heating Recovery Capacity : 700 KW +/- 2.5%

Minimum total Efficiency ratio (COP) while simultaneously generating hot water @55°C and cold water @ 6°C should be 5.65 with a maximum negative tolerance of 2.5% at all ambient temperature conditions between 5°C to 43°C at 100% as well as 75% capacity simultaneous cooling and heating .

Chiller should be ARI (AHRI) or Eurovent certified for 50Hz operation.

2.3 CHILLER SYSTEM MANAGER (CSM)

General:-

The chiller supplier shall provide a chiller plant management system to perform chiller plant control, automation, and energy management functions. The chiller plant control system shall have the capability to monitor and control chillers, primary and secondary pumps, condenser water pumps, cooling towers and motorized valves to provide the chiller plant operator with control, monitoring, and management information.

The controller should features high-level algorithms and user interface. The controller should be suitable for the management of 2- or 4-pipe systems, with regulation on one water circuit, for chiller or heat pump units and relevant mode change-over, and also with regulation on two circuits, with independent set-points and parameters, thus exploiting the simultaneous supply of chilled- and hot water.

The controller should manage up to 10 chiller units, with activation logic focused at the balancing of operation times and at the achievement of the highest energy efficiency. It should possible to define conditions of dynamic stand-by and priority as regards the units activation. The alarm management should be featured, with plain text descriptions and possible notification to remote recipients. There are minimum two relay outputs should be available, associated to unit- and device alarms.

The multi-level menu should feature the language selection and differentiated access profiles (user and maintenance).

The circuit temperatures and the status of both system- and unit- operation should be displayed, via one overview page plus detailed pages.

The regulation can be based on proportional- or proportional + integral logics, or also on a dead-band algorithm with dynamic adjustment, with relevant temperature inputs managed by the device.

The main Features should be, Set-point offset, outdoor temperature, demand limit should be included, with relevant analog inputs.

System Hardware :-

The chiller plant control system shall consist of the following hardware:

Chiller Gateway – The BMS vendor should procure the gateway based on their protocol from chiller vendor.

Field - mounted microprocessor - based chiller plant control panels BACnet compatible building controller & PROGRAMMABLE CONTROL MODULES (Input/output controller). The Building controller shall reside on a BACnet inter-network using the ISO 8802-3 (Ethernet or ARCNET (ASTM 878.1) Physical/data link layer protocol. Each building controller shall perform routing to a network of Custom Application and Application Specific Controllers. The Building controller shall also be capable of residing on client's high speed network which supports Internet Protocol (IP). The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 11.5 and 11.8, respectively, of ASHRAE Standard 135-95, to communicate with BACnet objects in the internet work. Objects supported shall include: Analog input, analog output, binary input, binary output and device.

PC workstation as primary graphical operator interface for monitoring and control.

Operator Interface :-

Work-stations shall be able to access all information available on the individual chiller microprocessor panel and all the points connected to the system. The work-stations shall reside on the same high speed network as the building controllers, and also be able to dial into the system.

System Applications :-

Chiller control system shall provide following applications:

Chiller control system should provide control of system leaving water temperature by adding chillers as the building cooling load increases. It should also be able to calculate chilled water set point sent to each chiller.

It should be able to optimize energy use by subtracting chillers when the cooling load does not require them to be enabled.

Provide runtime equalization and wear on each chiller by using different rotation schemes.

Control System condenser and chilled water pumps and associated equipment attached to it.

Add additional chiller based on

System chilled water set point
System chilled water supply temperature.

The temperature subtract algorithm based on:
Actual system delta T
System design delta T
Total available operating capacity (tonnage)
The capacity available after next chiller is subtracted.

Allows operator to force an add or subtract request from the screen.

Specify chiller rotation type as:

Normal
Peak (last on- first off
Base (first on - last off)
Swing (unevenly sized units)

Allow automatic rotation of sequence.

Control soft loading when system supply temperature is far from set point.

Provide text description to assist the operator in understanding current chiller plant control operation and help to anticipate the next chiller plant control decision.

Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

Rend Logs: The operator shall be able to define a custom trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable.

Alarm and Event Log: The operator shall be able to view all logged system alarms and events from any location in the system.

Reports and Logs: Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects easily.

- Custom Reports: Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report.
- Standard Reports. These reports shall be readily customized to the project by the owner.
- ASHRAE Guideline 3 Report: Provide a daily report that show the operating condition of each chiller as required by ASHRAE guideline 3.
- Snapshot Reports: When an equipment failure occurs, snapshot report should be triggered showing operating conditions at five minutes intervals an hour before failure.

Chiller Status Report - Provide an operating status report for each chiller. The report(s) shall provide the present status of all binary information and for analog information present value, today's average, and the month to date average for the following information to provide the operator with critical chiller operating data.

1. Compressor On/Off Status.
2. Compressor Starts/Run Hours - Compressor A, B
3. Phase 1/2/3 Percent RLA - Compressor A, B
4. Active Chiller Diagnostics or Alarms
5. Leaving Chilled Water Temperature
6. Entering Chilled Water Temperature
7. Water Heater Entering/Leaving Temperatures
8. Chilled Water Set point.
9. Condenser Fan Percent Airflow - Circuit 1, 2
10. Refrigerant Temperature Evaporator/Condenser - Circuit 1, 2
11. Operating Mode
12. Chiller Model and Serial Number
13. Percent RLA/Percent Current Limit
14. Outside Air Temperature
15. Zone Temperature (optional)

Diagnostics/Protection - the BAS system shall be able to alarm from all sensed points and diagnostic alarms sensed by the chiller controller

Alarm limits shall be designated for all sensed points. Individual chiller diagnostic and alarm statuses shall include the following latching items for each chiller:

1. Leaving Evaporator Sensor Failure
2. Entering Evaporator Sensor Failure
3. Low Chilled Water Temperature
4. Overload Trip - Compressor A, B, C, D
5. High Motor Temperature - Compressor A, B, C, D
6. Contactor Failure - Compressor A, B, C, D
7. High Oil Temperature - Compressor A, B, C, D
8. Oil Temperature Sensor Failure - Compressor A, B, C, D
9. Oil System Fault - Circuit 1, 2
10. Low Pressure Cutout - Circuit 1, 2
11. High Pressure Cutout - Circuit 1, 2
12. Solenoid Valve Failure - Circuit 1, 2
13. Phase Loss
14. External Interlock
15. Unit Controller

Individual chiller diagnostic and alarm statuses shall include the following non-latching items for each chiller:

1. Entering Evaporator Sensor Failure
2. Outdoor Air Temperature Sensor Failure
3. Zone Temperature Sensor Failure
4. High Voltage
5. Low Voltage
6. Phase Reversal
7. Phase Imbalance.
8. Chiller Water Flow Interlock
9. Unit Communication Loss
10. Low Chilled Water Temperature (unit off)
11. Circuit 1 - Pump down Timeout
12. Circuit 2 - Pump down Timeout
13. Condenser Fan Variable Speed Drive Fault

Scheduling: Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:

Weekly Schedule. Provide separate schedules for each day of the week.

Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule.

Holiday Schedules. Provide the capability for the operator to define up to [99] special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

Optimal Start/Stop. The scheduling application outlined above shall support an optimal start/stop algorithm.

Remote Communications: The system shall have the ability to dial out in the event of an alarm.

Maintenance Management: The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.

Chiller Sequencing: Provide applications software to properly sequence the chiller plant to minimize energy use. This application shall perform the following functions:

The chiller plant control application shall have the ability to control a maximum of 10 chillers of any type.

This application shall be able to control both constant and variable flow systems as well as parallel, series and decoupled piping configurations.

The chiller plant control application shall be able to control multiple chiller plants per site.

Alarm Indications - The chiller plant control status screens shall display chiller plant and individual chiller alarm messages.

PID Control: A PID (proportional-integral-derivative) algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.

Staggered Start: This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts shall be user-selectable.

Anti-Short Cycling: All binary output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

CSM should be with the following features

No. of units to be controlled	: 10 Nos.
Management of hydronic units	: Yes
Regulation on two water circuits	: Yes
User interface with display and commands Touch screen, multi-language	: Yes
Alarm management	: Yes
Management of stand-by, priority, rotation	: Yes
Integration into BMS/BAS systems	: Yes
Compatibility with variable primary flow systems	: Yes

3.0 COOLING TOWER (LOW HEIGHT F.R.P. INDUCED DRAFT MULTICELL TYPE)-

The capacity of cooling tower should be about 20% more than the heat rejection capacity of the equipment.

F. R. P. COOLING TOWER (INDUCED DRAFT MULTICELL TYPE)-

Cooling tower shall be induced draft type with multi cell construction, counter flow type vertical with fiberglass Reinforced plastic construction. The performance of the cooling towers shall be tested at site as per CTI norms/ procedures.

The components should be as under-

BASIN & CASING

The Basin and casing shall be supported by heavy gauge C Rolled section hot-dip galvanized steel for long life and durability.

Standard accessories shall include overflow, drain and brass make-up valve with plastic float.

The Casing and Basin shall be made out of FRP with both sides Gel coated for smoothness from inside and pigmented from outside.

AXIAL FANS

Fans shall be heavy duty Axial type statically balanced. The fans constructed of hollow extruded frp / aluminum alloy blades, installed in a closely fitted cowl with venturi air inlet. Fan screens shall be galvanized steel mesh and frame, bolted to the fan cowl.

FAN MOTOR

Suitable capacity totally enclosed fan-cooled fan motor(s), with 1.1 service factor will be furnished suitable for outdoor service on 415 volts, 50 hertz, and 3 phase AC supply.

The Fan Motor shall be high efficiency 4 pole, and shall be mounted out of moist Air stream. Suitable for VFD application.

DRIVE

The fan shall be mounted below the Fan bearing on a shaft, driven by a belt. The drive arrangement shall have FRP cover for protection.

FILL

The Cooling Tower Fill shall be of virgin PVC (polyvinyl chloride) make, of cross-fluted design for optimum heat transfer and efficiency. The cross fluted sheets shall be bonded together and the edges double folded for strength and durability. The PVC fill shall be resistant to rot, decay, or biological attack.

WATER DISTRIBUTION SYSTEM

The spray header and branches shall be constructed of Heavy duty, polyvinyl chloride pipe for corrosion resistance and shall have a steel connection to attach the external piping. The piping shall be removable for cleaning purposes. The water shall be distributed over the fill by precision molded ABS spray nozzles with large orifice openings to eliminate clogging.

ELIMINATORS

The eliminators shall be constructed entirely of inert polyvinyl chloride (PVC) in easily handled sections. The eliminator design shall incorporate two changes in air direction to assure complete removal of all entrained moisture from the discharge air stream. Maximum drift rate shall be less than 0.005% of the circulating water rate.

LOUVERS

The louvers shall be constructed from polyvinyl chloride (PVC)/ anodized aluminum. The louvers shall be mounted in easily removable frames for access to the Basin for maintenance. The louvers shall be suitable angled and spaced to prevent splash out and block direct sunlight.

FINISH

All Basin and casing materials will be 2 side finished in standard colour with NPG, u. v. stabilizer gel coat.

ACCESS LADDER

For sizes greater than 2.4 M wide a GI Ladder of formed / Rolled channels shall be provided with platform for easy access to Motor.

4.0 HYDRONIC PUMPS

VERTICAL / HORIZONTAL SPLIT CASING PUMPS

SPECIFICATIONS:

Pumps shall be vertical base mounted, single stage, Single / Double suction casing with foot mounted volute to allow removal and service of the entire rotating assembly without disturbing the pump connections & piping, electrical motor connections.

PUMP VOLUTE:

Pump volute shall be of cast iron with integrally cast pedestal support feet.

IMPELLER:

The impeller shall be cast bronze enclosed Single / Double suction type, balanced to ISO 1940-1:2003 / ANSI/HI 1.1-1.5-1994, section 1.4.6.1.3.1, balance grade G6.3 and keyed to the shaft and secured by a locking cap screw.

The lead-free bronze impeller shall be an enclosed - vane type, Single / Double suction design, hydraulically and dynamically balanced.

SHAFT:

The pump shaft shall be of Stainless steel precision ground to provide a true running rotating element.

Shaft sleeve design shall prevent corrosion and wear to the shaft. Material grade of shaft sleeve shall be ASTM I836, C89833.

WEAR RINGS:

Unless otherwise specified, renewable wear ring shall be furnished at least on the casing.

Pumps shall be fitted with lead-free bronze renewable case wear rings indexed with a dowelpin for fixed positioning. Material grade of wear rings shall be ASTMB148, C95400 or equal.

SEALS:

The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule.

Mechanical seals, at a minimum, shall have ceramic stationary seat again Carbon on rotating sealing face; and Buna elastomers or other suitable materials for continuous operation at 225 deg F. (100 deg C)

The shaft seals shall be capable of being serviced/replacement without disconnecting of the pump from piping and opening of the pump casing.

BEARINGS:

The pump shaft shall be adequately supported by the pump bearings to limit the shaft deflection to 0.002 inches.

Bearings shall be ball type, grease lubricated and locked to the shaft with positive locks of ample size to withstand any axial thrust loads. Bearing shall provide a minimum life of 10years when calculated at 50% of Best-Efficiency-Point for the scheduled pumps.

WORKING PRESSURE:

Maximum allowable working pressure (MAWP) for all the pressure containing parts shall in no case be less than the maximum discharge pressure produced by the pump at shut off(including tolerances), at the max suction pressure, for the maximum impeller diameter and the maximum continuous speed.

Note: MAWP shall not be less than 16 kg/cm² for condenser water pumps and not be less than 25 Kg/cm2 for chilled water pumps of primary and secondary applications.

Volute shall have gauge tapping at the suction and discharge nozzles and vent and drain tapping at the top and bottom.

VIBRATION:

The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994; section 1.4.6.1.1 or ISO 10816 for recommend acceptable unfiltered field vibration limits (as measured per HI 1.4.6.5.2) for pumps with rolling contact bearings.

SOUND LEVEL:

The maximum permissible sound pressure level of the pump shall not exceed 85 dbA measured at 1m from pump surface for the recommended range of operation.

COUPLING:

A flexible type, with optional center drop-out (Spacer) design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupler sleeve.

The coupling shall be shielded by a dual rated ANSI B15.1, Section 8 & OSHA 1910.219 Compliance coupling guard.

Base Plates:

Base plate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. The combined pump and motor base plate shall be sufficiently stiff as to limit the susceptibility of vibration. The minimum base plate stiffness shall conform to ANSI/HI 1.3.4-1997 for Horizontal Base plate Design standards.

The seismic capability of the pump shall allow it to withstand a horizontal load of 0.5g, excluding piping and/or fasteners used to anchor the pump to mounting pads or to the floor, without adversely affecting pump operation.

The base plate should be provided with lifting lugs for at least a four-point lift.

MOTORS:

Motor shall be of EFF 1 class type TEFC meeting IEC / NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the contractor as per factory recommendations after installation.

PUMP SELECTION:

The pump(s) selected shall conform to ANSI/HI 9.6.3.1 standards for Preferred Operating Region (POR) unless otherwise approved by the engineer. The pump NPSH shall conform to the ANSI/HI 9.6.1-1997 standards for Centrifugal and Vertical Pumps for NPSH Margin.

Pump with constant speed drives shall be capable of at least 5 % head increase at rated condition and at rated speed by replacing with a new impeller. Offered impeller shall in no case be less than the minimum diameter impeller.

The pumps for parallel operation shall have characteristics suitable for capacity sharing.

The shut off head in such cases shall not be less than 110 % of the rated head and no more than 120 % rated head.

Each pump shall be hydrostatically tested at factory as per Hydraulic Institute standards.

It shall then be thoroughly cleaned and painted with at least one coat of high-grade paint prior to shipment.

Pumps with variable speed drives shall be capable of operating continuously up to 105% of rated speed as well as operating briefly up to driver trip speed.

The pumps shall be factory manufactured, assembled and tested in an ISO 9001 approved facility.

Casing vent and Drain as per manufacturer standard shall be provided. As an option casing drain with an isolation valve and flanged piping terminated at the skid edge shall be provided. Base plate shall also provide with flanged drain connection.

MOTOR SELECTION:

Motor should be of variable frequency drive compatible.

The motor selection for mains operated pumps will be as given below Motor name plate rating : % of pump rated BKW Less than 4 kW : 140 % of rated pump BKW / Max BKW of the pump which ever is higher Less than 22 kW : 125 % of rated pump BKW / Max BKW of the pump which ever is higher 22 kW – 55 kW : 115 % of rated BKW Higher that 55 kW : 110 % of rated BKW

NOTE:

The motor nameplate rating for pumps under parallel operation shall not be less than the max BKW indicated on the pump data sheet (the power at the END of the curve for the rated impeller) or shall have the specified margin as per this clause which ever is greater.

The pump motors shall also be suitable for Start-up under open discharge valve condition.

SCOPE OF WORK OF THE VENDOR:

The scope of this consists of but is not necessarily limited to the following:

a) Manufacture and supply of pumps with associated motors, starters and accessories.
b) All associated items herein to be supplied delivered and installed.
c) Provide manufacturer's factory representatives services including co-ordination and start-up and testing supervision.
d) Testing (factory & field), start-up supervision, training and providing necessary documentation and recommendation of necessary tools for operation.
e) Carry out performance test run.

CAPACITY:

Actual pump capacity along with the power consumption at full and part load conditions shall be as shown in the form of performance curve in technical submittal.

ERECTION, INSPECTION, TESTING & COMMISSIONING:

EQUIPMENT INSTALLATION:

While loading/unloading the Contractor shall ensure no damage to equipment. The Contractor shall rectify any damage done. The decision of Engineer-in-charge is final.

The Engineer-in-charge shall see that the equipment is properly installed and connected, if not, the Contractor shall redo the work without any extra cost.

Any re shifting/relocating of equipment within the room shall not be paid extra.

The equipment shall be located as per drawing and the Contractor shall counter-check with the Engineer-in-charge before installation.

The Contractor should visually inspect the equipment along with the Engineer-in-charge and prepare a joint record of missing parts, or mountings or gauges or visual damages. The pump shall be carefully transported to the place of installation and installed on a foundation made for the equipment.

The equipment shall be leveled with leveling bolts or shims to the tolerances set by the Engineer-in-charge and equipment manufacturing recommendations and all foundations bolts shall be grouted.

The Contractor shall supply necessary foundation bolts, nuts and anti vibration mountings.

The Contractor's scope shall also include mounting of gauges and instruments. The installation, testing and commissioning of equipment shall be carried out in accordance with manufacturer's installation manual and/or the instructions of the Engineer-in-charge.

All drive motors shall be meggared with a meggar and readings recorded without load and with load.

PAINTING:

Prior to painting of the equipment, all surfaces shall be thoroughly de-scaled and cleaned.

The surface shall be quite dry and free from rust, scale, sharp points, burrs, weld spatter, flux, dust, grease, oil and other foreign materials before paint is applied.

The equipment shall be painted with two coats of appropriate primer and two coats of finish paint as per the painting specification requirements. The total dry film thickness shall be as per painting specification.

VENDOR SUBMITTALS:

Technical Data sheet for Pumps:
Refer technical data as mentioned in BOQ
Predicted performance characteristics curves
General arrangement drawings
Sectional arrangement drawings
Foundation detail drawing with load details

5.0 VARIABLE SPEED PUMPING SYSTEM SPECIFICATIONS FOR SECONDARY CHILLED WATER /HOT WATER APPLICATION

GENERAL

Variable Speed Pumping System

a. Individual system components
b. Pump logic control panel
c. Variable frequency drive (VFD)
d. Differential pressure transmitters (DPT)
e. Method of operation

Submittals shall consist of the following

a. Pump data sheets
b. System summary sheet
c. General arrangement drawing of the control panel indicating dimensions, required clearances and location of the field connection Submittals must be project specific. General submittals will not be accepted.

Vendor prerequisites:

A system integrator/representative/agent not actively engaged in the design and manufacturing of centrifugal pumps shall not be considered as the pump manufacturer. The pump manufacturer shall assume "Unit Responsibility" for the complete VSPS. Unit responsibility is defined as the responsibility to interface and commission all system components supplied to meet tender requirement.

The pump manufacturer shall be proven one in the design and construction of Variable Speed Pumping Systems (VSPS)

The pump manufacturer who is the supplier of VSPS system must have relevant expertise in all aspects of pre-sales activities like system design, application engineers and post sales activities like installation, commissioning and after sales-service. VSPS supplier must have commissioned satisfactory no. of such type of projects of Secondary chilled water VSPS in India up to the satisfaction of the Engineer-In-Charge.

The manufacturer should have ISO (International Standards Organization) per ISO 9001:2000. Proof of this certification shall be furnished during the time of submittal

Pump logic controller and VFDs shall be listed by Underwriter's Laboratories (UL) and should bear the symbol on the hardware supplied in the Variable Speed Pumping System.

Bidders shall comply with all sections of this specification relating to variable speed pumping system. Any deviation from this specification shall be mentioned clearly in writing. If no deviations for the specifications are noted, it is construed that the supplier shall bound by these specifications.

Pump Logic Controller Package

The manufacturers shall be acceptable subject to compliance with the stated specifications

Components of Pump Logic Control Panel

To supply and install Multi Pump Controller as per the design

The control system should include the Pump logic controller,

Variable frequency drive(s) and Differential pressure transmitters as indicated in the design

Pump logic control panel should house dedicated Multi Pump Controller, Variable frequency drive(s) and associated switchgears

Pump logic controller, Variable frequency drive(s), Differential pressure transmitters and related equipment shall be installed by the mechanical contractor as shown in the design

Input power wiring to the pump logic control panel and the output wiring to the motors shall be the scope of electrical contractor and to be done as indicated in the electrical drawings submitted for the specific project

Low voltage wiring for the Building Management System to be done by the BMS contractor from the pump logic control panel to the IBMS system

c) Specifications

Pump Logic Controller

The controller shall be specifically designed for variable speed pumping applications

Pump logic controller in built in Variable frequency drives are not accepted. Logic controller should be external to the drives used in the system

Multi Pump Controller shall have programs to safeguard the system against the following conditions Pump flow surges System Hunting End of curve protection

Multi Pump Controller shall be capable of receiving multiple analog input signals from zone differential pressure transmitters as indicated in the design. Multi Pump Controller will then select the analogue signal that has deviated most from its set point. The selected signal will then be used as the process input value for the hydraulic stabilization function.

Multi Pump Controller shall be capable of controlling up to six pumps in parallel

Multi Pump Controller shall be capable of accepting an additional analog input signal from a flow sensor. This input shall be used for the end of curve protection

Multi Pump Controller shall be capable of accepting 7 different set points activated through either clock program or individual digital inputs

Multi Pump Controller shall be capable of accepting additional analog input as external set point influential signal to vary the primary analog input signal. This external set point influential signal shall be user selectable from various types of signals like ambient temperature signal or like

Multi Pump Controller shall have program function to accept the pump curve data for optimizing the system performance in terms of energy consumption for the pump being controlled

The hydraulic stabilization program shall utilize a proportional integral control function. The proportional-integral values shall be user adjustable in the Multi Pump Controller over a finite range

Multi Pump Controller shall be self-prompting and all alarm messages shall be displayed in plain English. The operator panel shall have the following features:

Multi fault memory and recall of last 24 faults with time stamping Red fault light with related alarm message on default screen with graphical representation of the fault Soft touch membrane keypad switches

Multi Pump Controller shall have a display screen size of minimum 320 pixels X 240 pixels VGA display with backlight. Current status of settings and measured values are to be displayed in the default screen

Multi Pump Controller shall have an installation wizard to enable the user to configure the system with minimum assistance

Multi Pump Controller shall have minimum 2 level password protection to safeguard the settings against unwanted / unauthorized changes

Display should have menu driven function for the operation easiness

Multi Pump Controller shall be capable of performing the following pressure boosting function:
Low suction pressure cut out to protect the pumps against operating with insufficient suction pressure High system pressure cutout to protect the piping system against high-pressure conditions

The following communication features shall be provided to the BMS Remote start/stop of the VSPS through potential free contact from BMS

Individual pump start/stop/trip status from VSPS through potential free contact to BMS
The following communication features shall be provided to BMS system via RS-485 port utilizing Modbus protocol Individual analog input Individual pump/VFD on/off status System percent reference

System start/stop command
System operating mode
Individual pump kW consumption
Individual pump operating hours
Individual pump running speed in Hz/percentage reference
System flow, when optional flow sensor is provided

Multi Pump Controller shall have on board Ethernet port for connecting the VSPS to BMS. If given static IP address, Multi Pump Controller should be accessible over Intranet or Internet.

The pump logic controller shall be Multi Pump Controller or approved equal housed in a NEMA 1 enclosure

Variable Frequency Drive:

The variable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design

VFD, including all factory-installed options, is tested to UL standard 508.

VFD shall also meet C-UL and be CE marked and built to ISO 9001:2000 standards

VFD shall comply EMC directives as per IEC 61800-3:2004, category C1 with 50 meter motor cable (for power less than or equal to 90 Kw) & category C2 with 50 meter motor cable (for power more than 90 Kw)

VFD shall be housed in IP-41 enclosures for indoor applications. Wall mounted/VFDs with plastic enclosures shall not be acceptable. For out door applications, VFDs shall be housed in IP 55 enclosure.

VFD shall employ an advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no de-rating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life. Power factor shall be near unity regardless of speed or load.

VFD shall have balanced DC link chokes to minimize power line harmonics. VFDs without a DC link choke shall provide a 3% impedance line reactor.

Automatic motor adaptation (AMA) algorithm shall be available in the VFD. This feature shall allow for automatic adaptation of drive to meet the characteristics of the motor to have increased efficiency leading to additional energy savings. AMA feature should be able to configure without disconnecting the motor from the VFD

Output power switching shall be done without interlocks or damage to VFD

The following user adjustable parameters shall be provided in the VFD

Acceleration time
Deceleration time
Minimum frequency
Maximum frequency

VFD shall be compatible for Modbus protocol as standard

VFD shall have Automatic Energy Optimization (AEO) function. This feature shall reduce voltages when the drive is lightly loaded to provide a 3% to 10% additional energy savings

VFD shall be suitable for elevations to 1000 meters above sea level without de-rating. Maximum operating ambient temperature shall not be less than 40 deg Celsius. VFD shall be suitable for operation in environments up to 95% non-condensing relative humidity

VFD shall be capable of displaying the following data in plain English via 40 character alphanumeric display:

Frequency
Voltage
Current
Kw per hour consumption

Running hours
Run mode (remote/local)
Active power
RPM

VFD(s) shall be warranted for a period of 12 / 18 months.

VFD Panel:

VFD Panel shall be compartmentalized, free standing minimum IP41 Class of Panel (Indoor application), which shall ensure a proper isolation between the different VFDs and Switchgear Feeders. Rating of the Switch gears/ Feeders shall be as per SLD/ as required to complete the job up to the satisfaction of the engineer-in-charge.

All the outgoing and incoming cables shall be from the bottom of the panel. The panel shall have one incoming feeder and multiple outgoing feeders.

The controller system shall have a separate independent feeder, which shall be isolated from other incoming and outgoing power feeders.

A separate isolation transformer should be provided for powering up of Pump Logic Controller. Pump logic controller shall not utilize neutral of the supply directly without the use of isolation transformer.

Differential Pressure Transmitters:

Differential pressure transmitters shall be field mounted and shall transmit an isolated 4-20mA DC signal indicative of process variable to the pump logic controller via standard three/ two wire 24 DC system with Emission/Immunity confirming to EN61000-6-2/3.

Unit shall have stainless steel wetted parts with two 7/16" process connections. It shall be protected against radio frequency interference and shall have water tight, IP 55 electrical enclosure. Sensor should be capable of withstanding a burst pressure of 25 bar. Accuracy shall be within 2.5% BFSL (Best Fit Straight Line)

Sequence of operation

The system shall consist of Multi Pump Controller (MPC), multiple pump/VFD sets, with manual and automatic alternation and pump staging
The pumping system shall start upon the start command from the BMS when the Multi Pump Controller (MPC) is configured in "Remote" mode

If the Multi Pump Controller (MPC) is configured in "Local" mode, the system is started via the "Control Unit" at the panel and the pumping system shall operate automatically
Differential pressure transmitters shall be provided as indicated in the design
Each DPT shall send a 4-20 mA signal to the pump logic controller, indicative of the field condition

Multi Pump Controller shall compare each DPT signal against the set point and consider the most deviated signal for engineering the VFD/Pumps speed

Multi Pump Controller shall continuously scan the DPT signals and compare with the set point to control the most deviated zone

If the actual process variable (PV) is not met by the lead pump, Multi Pump Controller shall initiate a timed sequence to bring in a lag pump into operation

The lag pumps shall accelerate in tandem with the lead pump decelerating until both the pumps settle at same speed to meet the set point. (Process Variable PV = Set Point SP)

Further if the Process Variable (PV) changes, both the pump(s) speed should change together

During normal running sequence, Multi Pump Controller should attempt to de-stage pumps so that optimum number of pumps is always running in terms of energy consumption

In the event of lead pump/VFD fault, Multi Pump Controller automatically initiates a timed sequence to start the standby pump/VFD set in the variable speed mode. The standby variable speed pump shall be controlled by the Multi Pump Controller

VFD fault indication shall be continuously displayed on the display screen graphically until the fault is rectified and the controller has been manually reset

In the event of failure of zone differential pressure transmitter, its process variable signal shall be removed from the scan/compare sequence. Alternative zone differential pressure transmitter if available, shall remain in the scan/compare sequence

Upon differential pressure transmitter failure a plain English warning message shall be displayed on the Control Unit of Multi Pump Controller screen with a fault code

In the event of failure to receive all zone differential pressure transmitter signals, a user selectable number of VFD/Pump sets shall run at a user adjustable speed. Same shall be reset upon correction of the zone failure

VARIABLE FREQUENCY DRIVE

Product type	Dedicated HVAC Engineered design. General purpose products are not acceptable
Manufacturer	Shall have minimum 15 years experience in design and manufacturing VFDs.
Certification	UL, CE, C tick
VFD Design Requirements:	
Voltage variations	380-480 V $\pm$ 10%
Nominal supply frequency	50 / 60 Hz $\pm$ 5%
True Power Factor (λ)	$\geq$ 0.9 at nominal rated load
Displacement P.F. ($\cos \varphi$)	> 0.98
Harmonic current control	5% non-saturating dual reactors on both rails of DC bus. Swinging chokes which do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non linear) DC reactors to provide additional 3% AC chokes.

EMC Compliance (for emission and immunity)	a) For powers ≤90 kW : Shall comply with requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable. b) For powers >90 kW : Shall comply with requirements of IEC 61800-3 :2004, Category C2 with 50m motor cable.
VFD rated continuous output current	Meet or exceed the normal rated currents of standard IEC induction motors
Torque mode	Variable torque. Not programmable in constant torque mode for variable torque fan and pump applications
Torque ratings	a) Starting torque : Min 120% for 0.5 seconds b) Overload torque : 110% for 1 minute
Cable lengths	Upto 150 m for screened / armoured cable
Cable type	To allow for SWA (Single Wire Armour) cable & MICS (Mineral Insulated Copper Sheath) cable in the motor circuit.
V/f ratio	Dynamically varying; fixed V/f curves not acceptable. The factory default programming for this function shall be dynamic V/f.
Energy optimization function	Automatic energy optimization algorithm which continuously adjusts the applied voltage based on load and speed as factory default programming.
Output power switching	Without any interlocks and damage to VFD
Motor tuning function	Automatic, without having to decouple the load and motor.
Signal Isolation	Galvanic Isolation between power and control circuitry
Motor noise reduction	Adjustable carrier frequency modulation. VFDs with fixed switching frequency not acceptable
Ramp time	Programmable from 1 to 3,600 seconds

Service Conditions:

Ambient temperature with full VFD rated output current:	a) For powers ≤90 kW : 45 ^{0}C without derating b) For powers >90 kW : 40 ^{0}C without derating
Relative Humidity	0 to 95%. non condensing
Max. altitude above sea level	Upto 1000m without derating
AC line voltage variation	± 10% of nominal with full output
VFD enclosure protection	Minimum IP 20 without any secondary or additional enclosures
Aggressive environment	To offer circuit boards as per Class 3C2
Vibration	1.0 g

Protective features:

Motor overload protection	Class 20 I^2t electronic motor overload protection with automatic compensation for changes in motor speed.
Protective functions	Against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature.
Function at input phase loss	Auto derate and warning. Should cause no damage to VFD
Function at over temperature	Automatically reduce carrier frequency or auto derate.
Function at over load	Automatically reduce output current to a pre-programmed value
Alarm log	Record last 10 alarms with description of alarm, date & time.
Dry pump detection	Automatically detect and trip during a dry running situation or no flow condition, when used in pumping application
End of curve protection	Detect and display a warning or trip when encountering an end of curve situation, when used in pumping application

Interface Features:

Customer interface	Identical interface for full range of VFDs in a project.
Display type	Graphical, alphanumeric, 6 line, back lit
Auto – Manual operation	Control panel to have inbuilt Hand – Off – Auto Keys
Programming assistance key	Key for displaying on-line context sensitive assistance for programming and troubleshooting.
Protection against unauthorized access	2 level password protection for read & write to prevent unauthorized access.
Parameter up load / down load	Control panel with program up load / down load function and also size / rating independent parameters.
Language required	English
Indicating lamps	Red FAULT light, yellow WARNING light and a green POWER-ON light.

HVAC Features :

Quick set up menu	Menu with factory preset typical HVAC parameters
HVAC application menus	Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.
Speed control using 3 feedback signals	A three-feedback PID controller to control the speed of the VFD.
3 – zone control	Sum, difference, average, compare to common set point or compare to individual set point and select min. or max. deviating signal
Square root function of feedback signal	Calculate the square root of any / all individual feedback signals so that a pressure sensor can be used to measure air

	flow
PI programming	Auto tuning PI controller to facilitate faster commissioning
Installation of pressure sensor near to output of pump.	Actively adjust its set point based on flow, to facilitate such installation
Independent PID controllers	Three nos. additional PID controllers to control damper and valve positioners in the system and to provide set point reset
Floating point control interface	To increase/decrease speed in response to contact closures.
Meter displays	5 simultaneous meter displays on LCP
Display of feedback signals and set points	Display all connected feedback signals and its set points, in their own engg. units (e.g. : bar / ^{0}C etc.)
Sleep mode	Programmable and be able to stop the VFD in the following situations: a) Output frequency drops below set "sleep" level for a specified time, b) External contact commands that the VFD go into Sleep Mode, or c) Detects a no-flow situation.
Run permissive circuit	Receive a "system ready" signal before starting and also be capable of initiating an output "run request" signal to the external equipment.
Loss of load detection	Monitor a broken belt / loose coupling and indicate via key pad warning, relay output or serial communication. This function shall be based on torque and shall have a proof timer.
Real time clock	Integral feature and shall be capable of : a) Display current date & time on control panel b) Start / stop, change speed depending on time c) Time stamp all faults d) Program maintenance reminders based on time
Energy log	Function to monitor energy consumption pattern over programmable hours, days & weeks
Load profile	Store a load profile to assist in analyzing system demand and energy consumption
Sequential logic controller	To perform logic functions which has logic operators, comparators and timer functions.
Cascade controller for multiple motors	To control one variable speed motor and 2 fixed speed motors. Software to have full functionality and not just on / off.
Automatic restart	To automatically restart on receiving power after a power failure.
Adjustable ramp time	To avoid nuisance tripping, automatically adjust the ramp times.
Catching a spinning fan	To have a flying start function to effectively control an

	already spinning fan – in both forward and reverse direction
Programmable current limit	Programmable for site / application requirement. Shall be able to program for trip after an adjustable time.
Start Delay	A programmable start delay shall be provided.
Critical frequency lock out	a) Semi automatic setting of lock out range. b) 4 such lock out ranges to be provided

Inputs and Outputs

Minimum I/Os required	4 DI 2 DO 2 relay outputs - of min 240V AC, 2 A; 2 AI programmable for both 0-10V & 4-20 mA inputs; 1 AO of 4-20 mA
Display of analog signal	The Local Control Panel to display each analog signal in its engg. units for trouble shooting & setup.
Serial com interface for AI/DI	Capable of reading the status of all analog and digital inputs of the VFD through serial bus communications
Serial com interface for AO/DO	Capable to command all digital and analog outputs (including options) through the serial communication bus
Fire over ride mode	On receipt of a digital fire input, override all other local or remote commands, ignore most normal safety circuits including motor overload, display FIREMODE, select forward or reverse operation and speed source or preset speed.

AHU control through VFD

AHU control	3 additional PID Controllers shall be provided to control 3 external HVAC devices like chilled water valve, hot water valve and fresh air damper etc.
Additional inputs required	3 nos AI of 0-10V or Pt 1000 selectable
Additional outputs required	3 nos AO of 4-20 mA
Transmitter power supply	24 DC power supply to power transmitters and sensors

Serial Communications

Serial Com Port	EIA-485 (RS 485)
Standard serial com protocols	Modbus RTU , Backnet
Protocol options required	Bacnet MS/TP, Lonworks, Profibus, Devicenet
Connection to PC	Using USB port
Communication in case of power failure to VFD	Facility to provide optional 24 V DC back up power interface for keeping the controls section powered to keep communication to BMS

6.0 HYDRONIC PIPING

PREINSULATED PIPES

GENERAL

All underground and aboveground chilled water piping shall be insulated with Pre-insulated Polyurethane Foam.

PIPE

The pipe shall be MS ERW as specified in the Piping Section.

INSULATION

The pipe insulation shall be polyurethane foam with 36 kg/cu m minimum density, 90% minimum closed cell content, minimum compressive strength of 40 psi and initial thermal conductivity of 0.14 Btu/hr.ft^2 ^{0}F. The insulation shall completely fill the annular space between the service pipe and jacket and shall be bonded to both, the service pipe & jacket.

The insulation (PUF) shall be provided to the minimum thickness with cladding of minimum thickness as specified below:

S.No.	MS Pipe dia. / (mm)	PUF Thickness / (mm)	**OPTION-A** Thickness of G.I. (spirally wounded) Cladding / (Gauge)	**OPTION-B** Thickness of AL. (spirally wounded) Cladding / (Gauge)
1.	20 mm	32	26g	24g
2.	25 mm	32	26g	24g
3.	32 mm	32	26g	24g
4.	40 mm	32	26g	24g
5.	50 mm	32	26g	24g
6.	65 mm	32	26g	24g
7.	80 mm	40	26g	24g
8.	100 mm	40	26g	24g
9.	125mm	40	26g	24g
10.	150 mm	40	26g	24g
11.	200 mm	50	26g	24g
12.	250 mm	50	26g	24g
13.	300 mm	50	26g	24g
14.	350 mm	50	26g	24g
15.	400 mm	50	26g	24g
16.	450mm	50	26g	24g
17.	500mm	50	24g	22g
18.	550mm	50	24g	22g
19.	600mm	50	24g	22g
20.	650mm	50	24g	22g

UNDER GROUND PIPING & INSULATION EXECUTION:

Underground systems shall be buried in a trench of not less than 600 mm deeper than the top of the pipe & not less than 450mm wider than the combined OD of all piping systems. A minimum thickness of 600mm of compacted backfill over the top of the pipe is desirable.

Trench bottom shall have a minimum of 150mm of sand, pea gravel or specified backfill material, consolidated to suit operating weight & to act as a cushion for the piping.

Buried piping :

The outer protective insulation jacket shall be seamless, extruded, black, uv resistant, high-density polyethylene **(HDPE).** The minimum thickness of the **HDPE** jacket and PUF shall be as follows:

S.No.	MS Pipe dia. (mm)	PUF Thickness (mm)	Thickness of HDPE Cladding (mm)
1.	20 mm	29	2.5
2.	25 mm	36	2.5
3.	32 mm	31	2.5
4.	40 mm	36	2.5
5.	50 mm	37	3.0
6.	65 mm	39	3.0
7.	80 mm	43	3.0
8.	100 mm	40	3.2
9.	125mm	39	3.5
10.	150 mm	53	4.4
11.	200 mm	63	5.0
12.	250 mm	57	6.3
13.	300 mm	58	7.0
14.	350 mm	64	7.8
15.	400 mm	68	8.8
16.	450mm	77	9.8
17.	500mm	50	11.1
18.	550mm	65	11.1
19.	600mm	83	12.5
20.	650mm	58	12.5
21.	700mm	82	13.0
22.	750mm	104	15.0
23	800mm	79	15.0

However the exact thickness could vary marginally for underground piping based on the exact sizes of **HDPE** pipes available as per the chart given below:

FITINGS

Fitting can be fabricated at site over the carrier pipe and correct quantity of PUF shall be poured manually.

FIELD JOINTS INSULATION:

Field joints insulation shall consist of **PUF** poured manually in a site-fabricated GI cladding fixed around the joint.

HOW TO WELD TAPPING IN PRE-INSULATED PIPE

1. MARK THE TAPPING POSITION ON CLADDING WHERE THE TAPPING IS REQUIRED. MARK LENGTH 'A' AS SHOWN IN FIG.NO.1 FOLLOWED BY BELOW PROCEDURE FOR `A'
A= CLADDING DIA OF TAPPING +6"

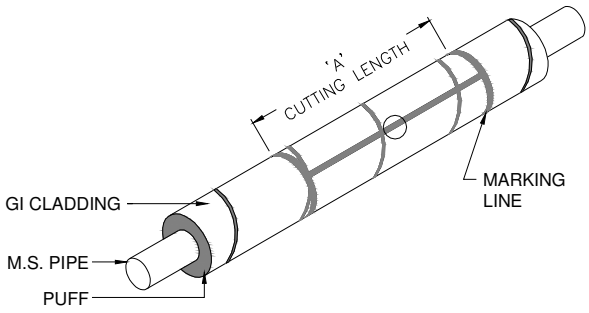


FIG.- 1

2. CUT MARKED LENGTH AS SHOWN IN FIG. NO. 1
BY USING HAND GRINDER SIZE ⅜" OR 10MM WITH 100MM DIAx1MM THICK PARTING WHEEL
(GRINDER MODEL-GWS6-100)

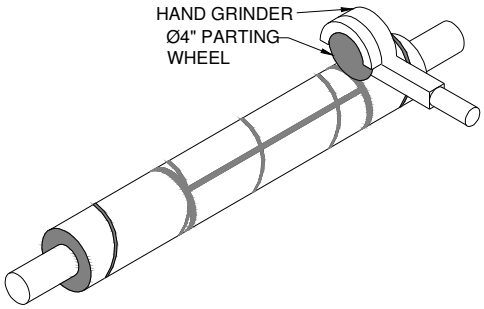


FIG.- 2

3. REMOVE OUTER CLADDING
AND PUF AS SHOWN IN FIG. NO. 3

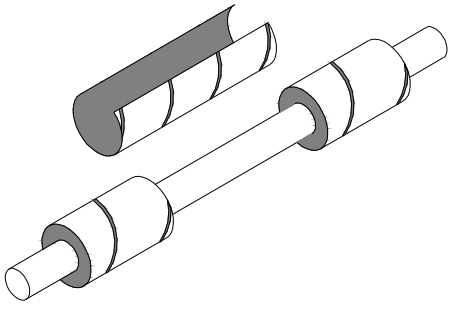


FIG.- 3

4. MARK THE SIZE OF TAPPING OF M.S. PIPE DIA & CUT BY USING GAS CUTTER AS SHOWN IN FIG. NO.4

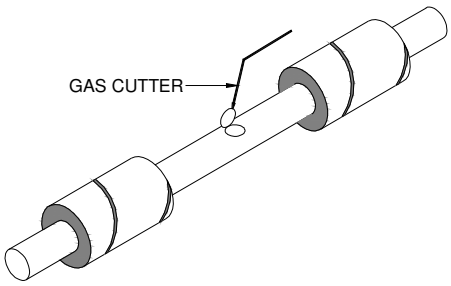


FIG.- 4

5. WELD THE TAPPING SIZE
PIPE AS SHOWN IN FIG. NO. 5

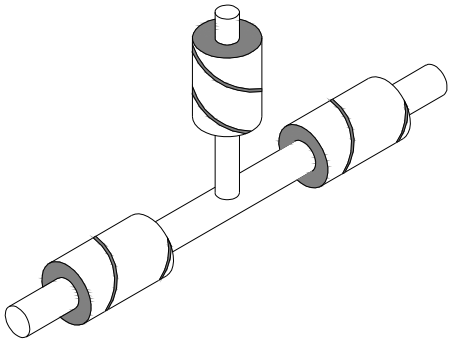


FIG.- 5

6. TAKE APPROPRIATE CHEMICAL AGAINTS DENSITY AND VOLUME, POUR IT IN THE CLADDING AFTER 10 SEC.
FOAMING WILL TAKES PLACE AS SHOWN FIG. NO. 6

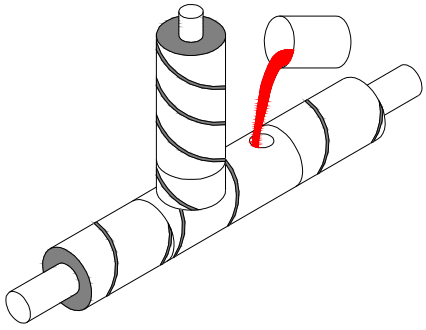


FIG.- 6

HOW TO WELD ELBOW IN PRE-INSULATED PIPE

1. MARK LENGTH 'A' AS SHOWN IN FIG.NO.1 FOLLOWED BY BELOW PROCEDURE FOR `A'
A= CLADDING DIA OF TAPPING +6"

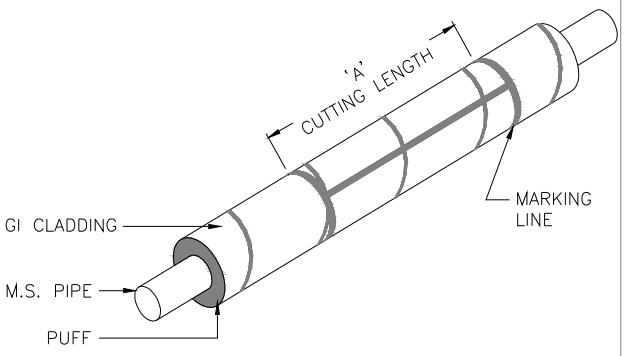


FIG.- 1

2. CUT MARKED LENGTH AS SHOWN IN FIG. NO. 1 BY USING HAND GRINDER SIZE 3/8" OR 10MM WITH 100MM DIAx1MM THICK PARTING WHEEL (GRINDER MODEL-GWS6-100)

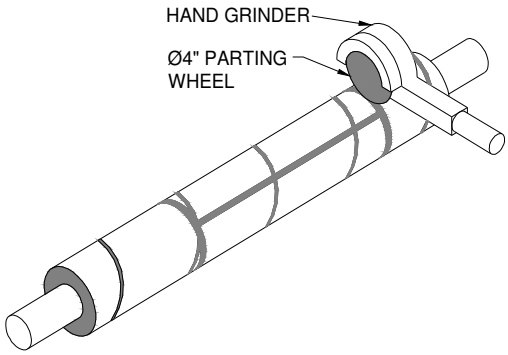


FIG.- 2

3. REMOVE OUTER CLADDING AND PUF & CUT THE M.S. PIPE WHERE ELBOW TO BE WELD AS SHOWN IN FIG. NO. 3

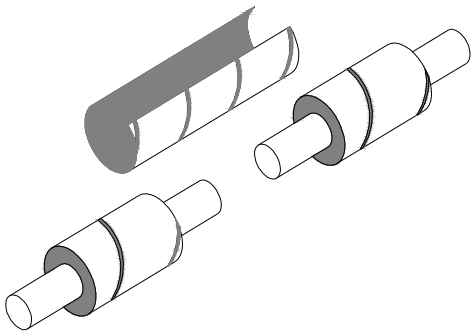


FIG.- 3

4. TAKE REQUIRED SIZE OF M.S. ELBOW AS SHOWN IN FIG. NO. 4

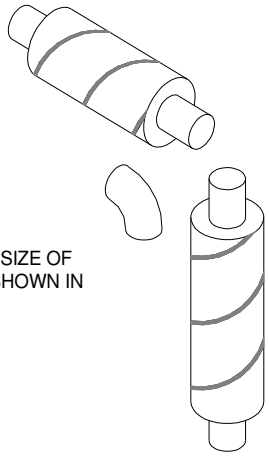


FIG.- 4

5. WELD THE ELBOW AS SHOWN IN FIG. NO. 5

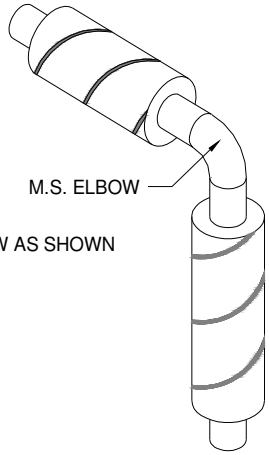


FIG.- 5

6. TAKE APPROPRIATE CHEMICAL AGAINTS DENSITY AND VOLUME, POUR IT IN THE CLADDING AFTER 10 SEC. FOAMING WILL TAKES PLACE AS SHOWN FIG. NO. 6

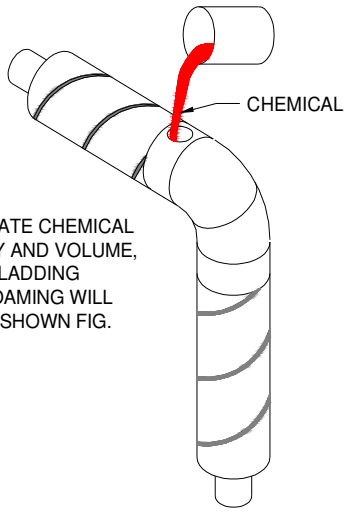


FIG.- 6

HOW TO WELD REDUCER IN PRE-INSULATED PIPE

1. MARK LENGTH 'A' AS SHOWN IN FIG.NO.1 FOLLOWED BY BELOW PROCEDURE FOR `A'
A= CLADDING DIA OF TAPPING +6"

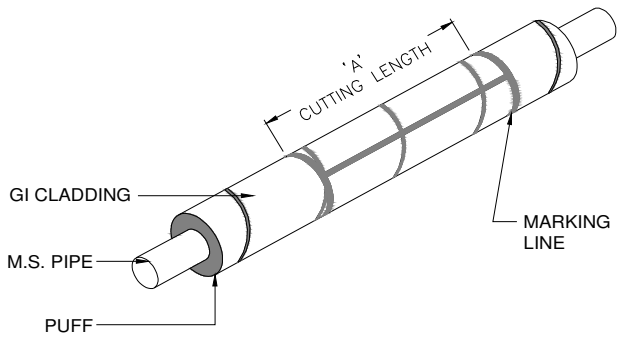


FIG.- 1

2. CUT MARKED LENGTH AS SHOWN IN FIG. NO. 1 BY USING HAND GRINDER SIZE 3/8" OR 10MM WITH 100MM DIAx1MM THICK PARTING WHEEL (GRINDER MODEL-GWS6-100)

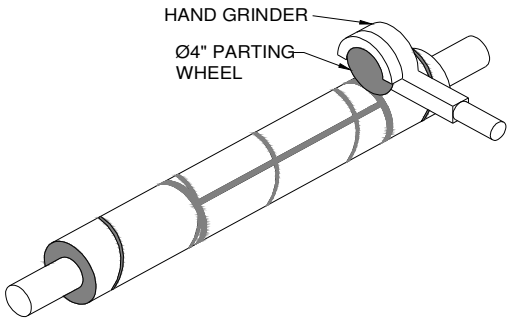


FIG.- 2

3. REMOVE OUTER CLADDING AND PUF & CUT THE M.S.PIPE WHERE REDUCER TO BE WELD AS SHOWN IN FIG. NO. 3

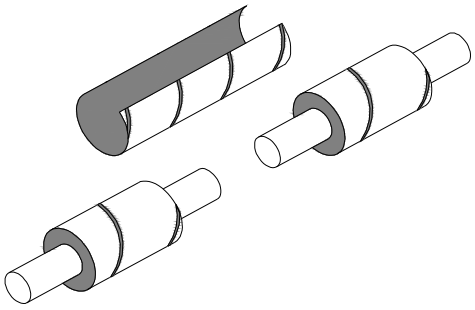


FIG.- 3

4. TAKE OTHER SIZE OF CLADDING PIPE (REDUCER SIZE) AND TAKE REQUIRED SIZE OF REDUCER AS SHOWN IN FIG. NO. 4

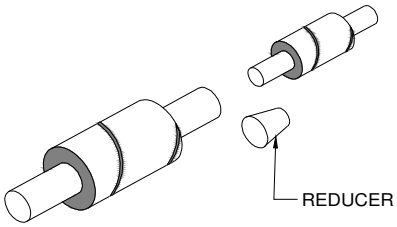


FIG.- 4

5. WELD THE REDUCER BETWEEN THE TWO SIZE PIPE AS SHOWN IN FIG. NO. 5

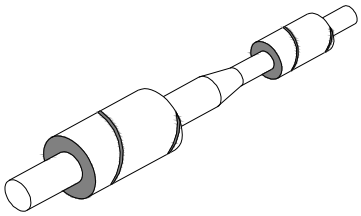


FIG.- 5

6. TAKE APPROPRIATE CHEMICAL AGAINTS DENSITY AND VOLUME, POUR IT IN THE CLADDING AFTER 10 SEC. FOAMING WILL TAKES PLACE AS SHOWN FIG. NO. 6

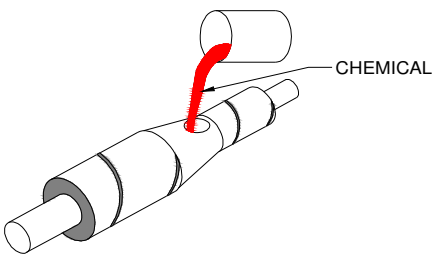
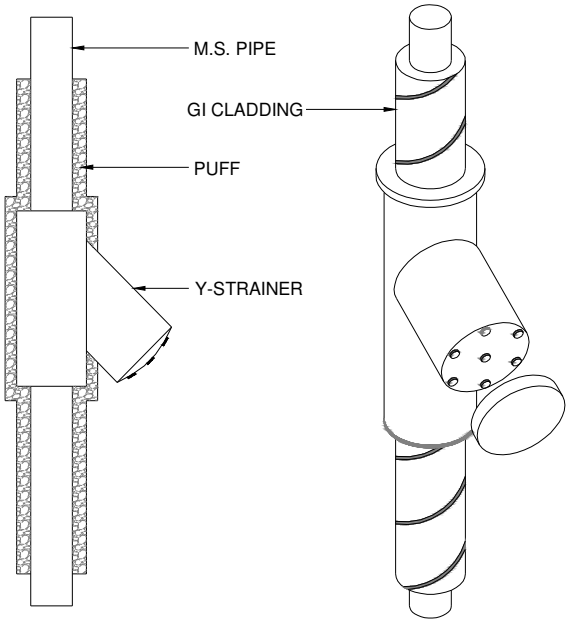


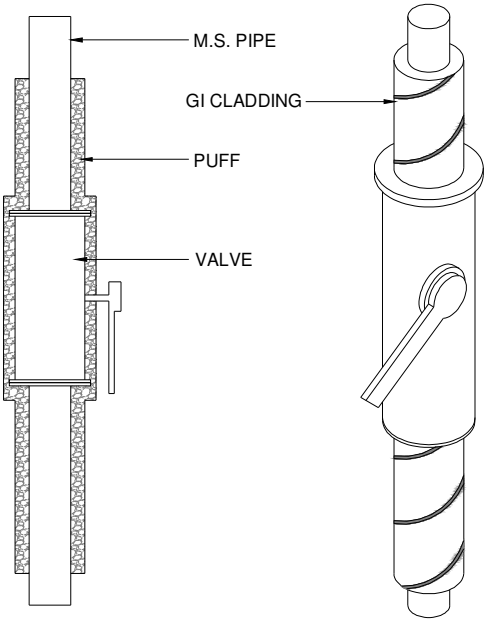
FIG.- 6

HOW TO WELD REDUCER IN PRE-INSULATED PIPE

1. FIT THE ALL NECESSARY VALVE WITH FITTING.
2. CARRIED THE LEAK CHECK.
3. AFTER LEAK CHECKING, MAKE AIR-TIGHT CLADDING.
4. TAKE APPROPRIATE CHEMICAL QTY. AND POUR IT IN TO THE CLADDING.



Y- STAINER



BUTTERFLY VALVE

The Consultant's drawings show the general layout of the piping. Piping herein specified is meant for chilled and drain water services.

MATERIAL

PIPES

CHILLED WATER

All pipes up to 150 mm dia. shall be M.S. E.R.W tube (black steel) heavy class as per I.S. 1239-79, Part-I with all the amendments.

All pipes 200 mm dia. and above shall be M.S. ER.W. Tube (black steel) as per I.S. 3589. The wall thickness shall be minimum 6mm.

DRAIN WATER SERVICES

CPVC pipe as per the relevant IS code

***JOINING WELD FITTING SCREWED FITTING*. FLANGES: ALL FLANGES WILL BE AS PER ASA – 150**: Sealing 3mm 4ply non-hardening rubber gasket between Material flanges and Teflon tape for threaded joints.

FITTINGS

All fittings shall be of MS class 'C' (Heavy class).

The dimensions of the fittings shall conform to IS1239/79 Part-II unless otherwise indicated, in the specifications.

All bends in sizes upto & including 150mm shall be ready made of heavy duty, wrought steel of appropriate class.

All bends in sizes 200mm and larger dia, shall be fabricated from pipes of the same dia. and thickness, with a minimum of 4 sections, and having a minimum center line radius of 1.5 diameter of pipes.

All fittings such as branches reducers etc., in all sizes shall be fabricated from pipes of the same dia, and thickness, and its length should be at least twice the dia of the pipe.

The branches may be welded straight to the main line, without making separate fittings.

Blank ends are to be formed with flanged joints and 6mm thick blank between flange pair for 150mm and over, in case where, a future extension is to be made otherwise blank end discs of 6mm thickness are to be welded on, with additional cross stiffeners from 50mm x 50mm M.S. heavy angles, for sizes upto 350mm, all ends larger than 400mm dia shall have dished ends.

FLANGES

All flanges shall be of mild steel as per IS 6392/71 and shall be steel slip-on-type, welded to the pipes, flange thickness shall be to suit class-II pressures.

Flanges may be tack welded into position, but all final welding shall be done with joints dismounted, 3mm thick gaskets shall be used with all flanged joints, the gaskets shall be fibre reinforced rubber as approved by the Engineer-in-charge.

Flanges shall be used as follows:

Counter flanges for equipment having flanged connections.

Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service (E.G. pumps, Refrigeration machines, air handling units etc.)

All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main lines for repair/replacement.

BUTTERFLY VALVES

Butterfly valves shall be installed where indicated. These shall have resilient seats which are (in-the-field) replaceable with moulded-in 0-rings to serve as a flange gasket. For sizes of 50 mm dia. to 150 mm dia. inclusive, a notched plate handle shall be provided for the control of the valve and indication of disk position. For sizes of 200 mm dia. and above, gear actuator shall be used. All butterfly valves shall be capable of bubble tight shut off. Butterfly valves shall comply with the recognized international standards.

Grooved ends butterfly valves may also be accepted. The valves shall be in accordance with the following: -

Grooved ends butterfly valves shall be bubble tight closing to ISO 5208 standard, enabling quick assembly with mechanical grooved coupling on ISO standard pipes.

The manufacturer shall provide independent laboratory tests. All testing records and data shall be submitted to the Architect/ Consultant for approval.

Bodies shall be made of ductile iron grade 400-18, completely coated with polyamide or products having equivalent functions or performance against corrosion, suitable for the temperature range of 0°C to 50°C. The valve shall provide dead end service at maximum rating.

The discs shall be made of ductile iron or brass ASTM B124, with EPDM coating for fresh water application.

The shafts stems shall be made of ANSI 420 stainless steel.

The control handles and the gear operators shall be suitable for locking in any position. The micro switches shall be built in the actuators and factory adjusted at full open and full closure. Manufacturer shall provide certificate of factory adjustment.
Valve electric operators shall be mounted on valves and tested at factory.
The valves shall have marking tag in accordance with ISO 5209 standard.

b. Butterfly valves/balancing valves and ball valves shall be provided as shown in the applicable drawings confirming to following specifications-

Size	**Construction**	**Ends**
15 mm to 40 mm	Ball valve with forged	Screwed female.

(Ball Valve)	carbon steel /brass body & S.S. working parts.	
50 mm & above (Butterfly Valve)	Moulded liner cast iron body of Regulating type with locking facility.	Nylon Disc. seat black nitrile suitable up to 80°C wafer type confirming to IS : 1536

CHECK VALVES

The body of the check valves shall be made of cast iron to BS EN1561 and ISO 185 while the flaps/discs shall be made of Bronze to ISO 197-4 or ductile cast iron. The discs of swing check valves shall be of light construction and pivot on a spindle secured by two phosphor-bronzed hangers. Each valve shall be fitted with a stop to prevent undue movement of the flap and shall be as silent as possible in operation.
The discs of lift check valves shall be provided with means of guiding the discs and preventing components from becoming detached in service.
Recoil check valves with size 100 mm and above should have removable cover on top of the outlet body casing to facilitate inspection of bearings and movement door.

Check valves shall be provided as shown in the drawings and shall confirm to the following specifications.

Size	**Construction**	**Ends**
15mm to 50mm	Gun Metal	Screwed Female.
65mm & above	Body : Cast Iron Disc. & Seat : Gun Metal	Flanged

Swing check valves shall normally be used in all water services and shall confirm to IS: 5312 or BS: 5153. Lift type may be used in horizontal run. Air release and clean out plunge shall be provided and valves shall be suitable for 21 Kg/cm^2 test pressure.

STRAINERS

Strainers shall be of the single or the double type as indicated with connections screwed thread for bores of up to and including 50 mm and flanged for bores of 65 mm and above.

Strainers of up to 50 mm shall be of gunmetal or bronze. The bodies of single strainers of 65 mm bore and above and all double strainers shall be of cast iron.
Straining cages and their supporting structure shall be of non-ferrous metal or stainless steel with 1.5 mm diameter perforations or finer if indicated. Cage shall be at least five times the cross-sectional area of the pipe.
Double strainers shall incorporate a changeover device to enable either strainer to be selected and to isolate the idle strainer from the fluid flow.

Strainer shall have flanges for connecting the piping. Strainer shall be designed so as to enable blowing out accumulated dirt and facility removal and replacement of the screen without disconnecting from main piping. Each strainer shall be provided with equal size isolating valves so that strainer may be cleaned without draining the system.

2 WAY MODULATING / SELF DYNAMIC BALANCING/ FLOW CONTROL VALVE (SUITABLE APPLICATION- AHU's (preferred) & FCU's (case to case)

The Valve should be self balancing dynamic flow control valves that are pressure independent, two-way, modulating to accept digital or analog input signals and provide **flow feedback signal to the control system.**

The valves should accept 2-10V DC, 0-10 V DC, 4-20 mA, digital 3-point floating or PWM input signals and shall be capable of providing 4-20 mA or 2-10V DC flow feedback signal to the control system. Each valve should have 51 adjustable maximum flow rate setting to enable flow limitation and balancing to the coils or zones that the valves are controlling. All valve actuators are microprocessor based with a self-calibrating feature. The valves from 15 to 40 mm shall be designed for double union piping connections while above 40 mm of the wafer style for fitting between flanges, to be provided by others.

VALVE SPECIFICATIONS

	For 15 to 40 mm	**For 50 to 150 mm**
Static Pressure	2500 kPa, 360 psi	400 kpa, 580 psi
Media Temperature	-20 ° to 120 °C, -4 ° to 248 °F	-20 ° to 120 °C, -4 ° to 248 °F
Ambient Temperature	10 ° to 54 °C, 14 ° to 13 °F	10 ° to 54 °C, 14 ° to 131 °F
Body material	Forged Brass ASTM B584	Ductile Iron, ASTM A536-65T, Class 60-45-18
Internal Components	AISI Type 316 Stainless Steel	AISI Type 316 Stainless Steel
Test Ports/ Body Tapings	1/4" NPT (Body Tapings)	1/4" ISO (Test Ports)
End Connections	Bronze Alloy ISO, NPT or Sweat	Wafer style (by others)
Stem Seals	EPDM and Nitrile O-Rings	EPDM
Maximum Close Off Pressure	700 kPaD, 101 psi	700 kPaD, 101 psi
Maximum Operational .P	320 kPaD, 46 psi	400 kPaD, 58 psid

ACTUATOR SPECIFICATIONS FOR ALL SIZES

Supply Voltage **:** 22-28V AC or 28-32V DC
Power Consumption **:** 20VA @ 26 V AC
Frequency **:** 50/60 HZ
Control Input **:** 2-10V DC, 4-20mA, 3-point floating, PWM
Position Output **:** 2-10V DC 4-20mA
Turn Time **:** 150 seconds (from closed to fully open valve)
Electrical Connection **:** 15mm Grommet connection
Direction of Rotation **:** Bi-directional
Humidity Rating **:** Fully Coated Electronic Board
Housing Material **:** Aluminium
Housing Insulation **:** IP 44

AUTOMATIC AIR VENTS

Automatic air vents shall be used where indicated. They shall have gunmetal or brass bodies, non-ferrous or stainless steel floats and guides, non-corrodible valves and seats. Each automatic air vent shall be controlled by a lock-shield valve. Air release pipes shall be run to discharge at the nearest suitable and visible point and agreed by the Architect.

THERMOMETERS - LIQUID IMMERSION

Thermometers shall be of the mercury-in-glass type of at least 150 mm long with accuracy of ± 0.5°C.

Unless otherwise specified, material of thermometer pocket shall be of stainless steel grade 316.

The thermometer will be dial type with 4" dial and suitable range as approved and at following locations.

On inlet and outlet of each cooling coil & Chillers.

PRESSURE GAUGES FOR WATER SYSTEMS

Pressure gauges shall comply with BS EN 837-1 calibrated in kPa from zero to not less than 1.3 times and not more than twice the operating pressure of the respective equipment/system and shall be accurate to 1.5% of full scale reading, unless otherwise specified.

The dials of gauges shall not be less than 100 mm diameter and the cases shall be of polished brass or chromium-plated mild steel with optical sight glass.

Pressure gauges used solely to indicate the head and pressure of water shall be provided with an adjustable red pointer set to indicate the normal working pressure or head of the system.

PIPING INSTALLATIONS

Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

Install piping to permit valve servicing.

Install piping at indicated slopes.

Install piping free of sags and bends.

Install fittings for changes in direction and branch connections.

Install piping to allow application of insulation.

Select system components with pressure rating equal to or greater than system operating pressure.

Install drains, consisting of a tee fitting, ball valve, and short threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

Reduce pipe sizes using eccentric reducer fitting installed with level side up.

Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Install flanges in piping, 65mmdia.and larger, at final connections of equipment and elsewhere as indicated.

Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in the drawing.

Install sleeves for piping penetrations of walls, ceilings, and floors.

Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.

Install sleeve seals for piping penetrations of concrete walls and slabs.

PIPE JOINT CONSTRUCTION

Join pipe and fittings according to the following requirements..

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

HYDRONIC SPECIALTIES INSTALLATION

Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

Install piping from air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

Install in-line air separators in pump suction. Install drain valve on air separators 25mm dia. and larger.

Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 1200 mm above the floor. Install feeder in minimum DN 20 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install DN 20 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

Install tank fittings that are shipped loose.
Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

TERMINAL EQUIPMENT CONNECTIONS

Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

Install control valves in accessible locations close to connected equipment.

Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

Install ports for pressure gages and thermometers at coil inlet and outlet connections as specified in the drawings.

CHEMICAL TREATMENT

Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:

FIELD QUALITY CONTROL

Prepare hydronic piping as follows:

Leave joints, including welds, uninsulated and exposed for examination during test.

Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

Perform the following tests on hydronic piping:

Prepare written report of testing.

Perform the following before operating the system:

Open manual valves fully.
Inspect pumps for proper rotation.
Set makeup pressure-reducing valves for required system pressure.
Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
Set temperature controls so all coils are calling for full flow.
Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
Verify lubrication of motors and bearings.

WELDING - IN ACCORDANCE TO THE ASME SECTION IX

GENERAL REQUIREMENTS

This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work. Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.

Certified welders, previously certified by test, may be accepted for the work without re-certification provided that all of the following conditions are fulfilled:

b. Submit copies of welder certification test records in accordance with this Division.

c. Testing was performed by an independent testing laboratory.

d. The welding procedures and welders are certified in accordance with the "ASME Section IX and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.

e. Certification has been within a one (1) year period from the start of the project.

Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be

properly labeled and designed to give maximum protection from moisture and to assure safe handling.

Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.

Before assigning welders to the work, provide the architect with their names, together with certification that each individual is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.

Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

PIPING WELDING In accordance to the ASME Section IX

A. Welding materials shall comply with the "ASME section IX Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a certified welder using qualified welding procedures.

WELDING In accordance to the ASME Section IX

B. Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.

C. Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.

D. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.

E. Store electrodes in a dry heated area; keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

CODES, PERMITS AND INSPECTIONS

F. Materials furnished and work installed shall comply with the National Building Code of India including all Standards and Specifications referenced therein, the National Fire Protection Association, requirements of the local utility companies, and with authorities having jurisdiction. Materials and equipment furnished for the electrical portion of the fire protection systems shall comply with the National Building Code of India, the Indian National Electrical Code IS Standard Number SP 30 reaffirmed 2005, and bear the approval label of or shall be listed by the Underwriters' Laboratories, Inc.

G. HVAC contractor shall provide labor, materials, services, apparatus and drawings required to comply with applicable laws, ordinances, rules and regulations, whether or not shown on the drawings and/or specified.

H. HVAC contractor shall obtain and pay for required permits associated with approval and installation of plumbing systems and associated appurtenances.

GUARANTEES AND CERTIFICATES

I. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract, shall be replaced or repaired at no extra cost to the Employer for the duration of the stipulated guarantee periods.

1. Unless specifically indicated otherwise, the duration of the guarantee period shall be two years following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing, etc., prior to occupancy will not be considered part of the warranty period.

QUIET OPERATION AND VIBRATION CONTROL

J. Equipment and associated items shall operate under conditions of load without sound or vibration deemed objectionable by the Architect. In the case of moving equipment, sound or vibration noticeable outside of the room in which it is installed, or noticeable within the room in which it is installed, shall be deemed objectionable. Sound or vibration deemed objectionable shall be corrected in an approved manner at no extra cost to the Employer. Vibration control shall be provided by means of approved vibration isolators and installed in accordance with the isolator manufacturer's recommendations.

K. The sound pressure levels around mechanical and electrical equipment (fans, pumps, motors, etc.) in equipment spaces shall not exceed 85 dBA at any point three (3) feet from the equipment, with all equipment in the room operating. The sound criteria apply to the complete range of each piece of equipment.

COORDINATION

L. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.

M. Coordination drawings shall be prepared as defined in the Tender. No installation of permanent systems shall proceed until the coordination drawings are reviewed and approved by the Architect and the Supervising Engineer. No extra charges shall be allowed for changes required to accommodate installation of systems provided under other divisions of this contract.

N. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.

O. Mandatory Coordination Drawings include the following:

1. Coordination with cast in place concrete: Support and routing of piping and components coordinated with Cast-in-place Reinforced Concrete Structure including location, size and configuration of sleeves, hangers, inserts, brackets in or supported by concrete beams, slabs, columns, walls or foundation structures. Prepare

coordination drawings coordinated with Concrete Formwork Shop Drawings and Good for Construction Structural Drawings.

a. Show, locate and detail penetration of HVAC assemblies.

b. Show, locate and detail coordination with reinforcing.

2. Coordination with Mechanical, Plumbing, and Electrical Work: Support and routing of sprinkler piping and components coordinated with duct work, mechanical systems piping and components, plumbing piping and components, electrical power distribution components, and electrical lighting system components.

3. Coordination with General Construction and Finish Work: Support and routing of sprinkler piping and components coordinated with general construction and finish systems including, but not limited to, suspended ceiling systems, wall cladding and finishes, glazing systems, and non-structural fire-rated assemblies.

P. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Employer.

Q. Work installed in the absence of Architect Approved Coordination Drawings, shall be subject to removal and replacement at the sole discretion of the Architect. The complete cost of such removal and replacement shall be the exclusive cost of the Contractor and no extra charges or claims of any kind will be permitted.

SHOP DRAWINGS & PRODUCT DATA

R. Shop drawings, product data shall be submitted as required.

S. The following shall be submitted by the Contractor for review:

1. Scale shop drawings showing system components with sizing indicated, including but not limited to:

a. Equipment locations
b. Piping and valves
c. Insert and sleeve locations
d. Hangers, anchors and guides
e. Expansion joints and loops
f. Access doors

2. Product data for system components and materials, including compliance with construction standards and applicable codes.

3. Samples for each significant component of the fire protection system to confirm finishes and trim of items exposed to view such as sprinkler heads, fixture trim, escutcheon plates, clean out plates, and exposed valves.

T. The value of shop drawings, product data shall be identified as a line item in the Schedule of Values and included in the Schedule of Item Rates and Unit Quantities. If the shop drawings, product data are not submitted as required, their value shall credited to Employer in the form of a Variance. The value of these items shall be a minimum of one (1.0) percent of this Contract Amount.

U. Work installed in the absence of Architect Approved Shop Drawings and other submittals shall be subject to removal and replacement at the sole discretion of the Architect. The complete cost of such removal and replacement shall be the exclusive cost of the Contractor and no extra charges or claims of any kind will be permitted.

EMPLOYER INSTRUCTION

V. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Employer in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Employer's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be 80 man hours. The instruction period shall be broken into segments at the discretion of the Employer.

1. Notify the Architect, the Supervising Engineer, the Employer's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Employer at least one (1) week prior to conducting same.
2. Forward to the Architect the signatures of all those present for the instruction periods.

Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures of Indian Standards to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, and then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, and then retest to demonstrate compliance. Verify that each fire pump performs as indicated.

Perform the following field tests and inspections and prepare test reports:

Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

Final Checks before Startup: Perform the following preventive-maintenance operations and Checks:

Lubricate oil-lubrication-type bearings.

Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.

Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.

Starting procedure for pumps is as follows:

Prime pump by opening suction valve and closing drains, and prepare pump for operation.

Open sealing-liquid supply valves if pump is so fitted.

Start motor.

Open discharge valve slowly.

Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.

Check general mechanical operation of pump and motor.

7.0 PIPE HANGERS

SPRING HANGERS

These shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod.

The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion.

Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the edge of the hole and short circuiting the spring.

Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

SPRING AND DOUBLE DEFLECTION NEOPRENE HANGERS

These shall be as Type 'E' but incorporate an 8 mm deflection neoprene element at the top of the hanger box.

The neoprene element shall be molded with a rod isolation bushing that passes through the upper part of the hanger box.

PRE-COMPRESSED SPRING HANGERS

These shall be pre-compressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation.

The hangers shall be designed with a release mechanism to free the spring after the installation is completed and the hanger is subjected to its full load.

SPRING HANGERS (DUCTWORK SUPPORT)

These shall be provided with top and bottom eye bolts, the top one for bolting to the flat iron hanger strap and the bottom one for bolting to the flat iron ductwork strap.

DOUBLE DEFLECTION NEOPRENE HANGERS

These shall consist of a double deflection neoprene unit as Type 'C which is mounted on the bottom of the hanger box.

The neoprene unit shall be molded with a rod isolation bushing that passes through the hanger box.

SPLIT WALL/FLOOR SEALS

These shall consist of two bolted pipe halves with 19 mm or thicker neoprene sponge bonded to the inner faces.

Seals shall project a minimum of 25 mm past either face of the walls.

Where temperatures exceed 115°C, fiberglass shall be used in lieu of the sponge.

HORIZONTAL THRUST RESTRAINERS

Air handling equipment shall be protected where necessary against excessive displacement which might result from high air thrusts in relation to the equipment weight.

The horizontal thrust restraint shall consist of a spring element located in a neoprene cup manufactured with a grommet to prevent short circuiting of the threaded rod. The thrust assembly shall be so designed that the spring element can be presented for thrust at the factory and adjusted at the site to allow for a maximum of 6 mm movement at start and stop.

The assembly shall be furnished with one threaded rod and two angle brackets for attachment to both the equipment and ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centre line of thrust and symmetrically on either side of the unit.

BUILT IN INERTIA BLOCK PLANT SUPPORT

Where specified in the Contract Document, the Contractor (or the Building Contractor) shall provide plant foundations and housekeeping pads in the form of large concrete blocks recessed into the main floor slab.
Unless otherwise indicated, the sides and bottom of the embedded portion of the concrete block shall be lined with a minimum of 50 mm thick 'load bearing' cork pad to the following specification.

DENSITY OF VIBRATION ISOLATORS

Density Designation	Density (kg/m^3)	Loading (kg/m^2)
Light	3.0-4.5	250- 2500
Medium	5.5-6.0	2500 - 20000
Heavy	7.0-7.5	15000-30000

PLANT/EQUIPMENT VIBRATION ISOLATION

GENERAL

All vibration isolators shall have their known undeflected heights or calibration markings so that, after adjustment when carrying their loads, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that correct degree of vibration isolation is being achieved according to the design.

The static deflection of the isolator at each support point shall not differ from the design objective for the equipment as a whole by more than ± 10%.

The ratio of lateral to vertical stiffness for spring shall be not less than 0.9 or greater than 1.5.

All neoprene mountings shall have hardness of 40 to 65 udometer, after minimum aging of 20 days or corresponding over-aging.

In order to resist corrosion, all vibration isolation mountings and hangers shall be treated as follows: -

(a) Springs to be neoprene coated or hot dip galvanized.
(b) Wearing hardware to be cadmium plated steel or stainless steel of an appropriate grade.
(C) All other metal parts to be hot dip galvanized.

For any Contract, all vibration isolators and associated equipment bases shall whenever possible be of the product of a single manufacturer. Acceptable manufacturer's systems shall strictly comply with the design intent of this and/or the Particular Specification.

SELECTION GUIDE FOR EQUIPMENT BASE AND VIBRATION ISOLATOR

Unless otherwise specified, the selection of the type of equipment base and vibration isolator (mounting/hanger) for different plant/equipment and on different floor spans and levels shall follow the requirements and the static deflection of the vibration isolator selected shall either provide a minimum isolation efficiency of 90% in ground floor areas and 95% in upper level areas. However, the Contractor shall be responsible to ensure that the selected vibration isolation system is suitable for the specific plant/equipment and the specific building structure on which the plant/equipment is mounted.

The Contractor shall provide more efficient isolation than those suggested, in case if the adjacent occupied space is a noise critical area such as board room and executive office. Advice from vibration isolator manufacturer shall be sought if necessary.

8.0 FLEXIBLE PIPE CONNECTORS

Flexible connector shall consist of a single or twin-sphere body manufactured with reinforced rubber, the ends of which are raised and wire reinforced to form the cuffs for sealing purposes. The cuffs shall be backed by floating steel flanges.

The rubber body shall be reinforced by multi-layered nylon tire cord fabric.

Flexible connectors shall have a life in excess of 10 years under the design working conditions.

The rubber membranes shall have an indelible identification system to clearly identify the model and hence suitability for the application and working conditions and has the date of manufacture moulded into the cover to ensure that no units that have exceeded the recommended shelf life are used.

Straight connectors shall be of the twin-sphere construction whilst elbow connectors shall be of the single-sphere construction.

Straight connectors connected to resiliency supported equipment shall be equipped with acoustical control cables to prevent excessive elongation of the connectors if the system operating pressure is in excess of the value recommended by the manufacturer for use without control cables.

Acoustical control cable assembly shall consist of four large triangle anchor plates, two control cables with large swaged on end fittings and 13 mm thick acoustical washer bushings of sufficiently large load bearing area to isolate the end fittings, axially and laterally.

FLEXIBLE METALLIC HOSE

Allowable stress levels should be within BS 5500: 1985.

The corrugated seamless hose body shall be of the annular and close pitched type.
For all ferrous applications, the hose body and the braid shall be manufactured from stainless steel material to BS 1449 Part 2 Type 321S31. End terminations shall be carbon steel threaded male nipples to BS 21 (BSP) for 65 mm size and below and flanges to BS 4504 NP Standard for 75 mm and above. All Metallic Houses & the special clamps should be suitable for holding 300 PSIG (20.6 kg/cm²).

9.0 CLOSED PRESSURISED EXPANSION TANK-

An adequately sized (as mentioned in schedule of equipment) Closed Pressurised expansion tank to take care of the expansion of water due to the temperature variations in the system shall be provided in the chilled water circuit. It should be bladder type & insulated with 80 / 50 mm thick expanded polystyrene as specified & complete with receiving fittings. The bladder material shall be of nylon coated with butyl rubber.

10.0 AUTOMATIC VACUUM DEGASSER FOR HEATING AND COOLING INSTALLATIONS

The Vacuum Degasser should be a fully automatic degasser for heating and cooling installations and a working pressure of up to 6 bar. It should have electronic control and should offer numerous facilities for reading system information, status and logged data. The Degasser should be BMS compatible. The device should be supplied with ready to use, complete with flexible connection hoses, fitted with coupling nuts. By adjusting a number of parameters, in combination with adjusting 2 valves in the inlet and outlet piping, the degasser should be optimally adjusted in a fast and easy way for any particular installation.

The Degasser should be fitted with a high-grade, vertical, multistage centrifugal pump and intelligent control. The comprehensive control should offer numerous facilities for reading system information, status and logged data. The Degasser should be able to measure the installation pressure continuously and, if necessary, fill up the installation with degassed fluid. This keeps an installation on pressure continuously, without the need for additional devices.

The Degasser should be fitted with an automatic switch. which should continuously register when gases are removed. It should be able to switch off the Degasser when it is not required to run. Hence , it should only run when required.

Control:

The Various Parameters that can be read from the Interface of the system should be:

- Cutting-off times
- Refill pressure
- Start times
- Refill alarms
- Maximum system pressure
- Desired system pressure
- Operation time
- Status
- Refill history
- Failure data
- Degassing history

11.0 AIR & DIRT SEPERATOR:

The combined Air & Dirt Separator unit allows it not just to remove free and dissolved air but also dirt particles of upto 10 microns without any change to the designed Pressure drop.The special design of the tube is at the heart of the unique combined action of the separator. Dirt particles of all sizes should sink to the bottom of the unit and collect in the dirt chamber, whilst the air bubbles rise and collect in the air chamber. The dirt can be flushed out while the system is in full operation through the drain valve. The air should release via the automatic air vent. The medium used to de-aerate and remove dirt shall be manufactured of Steel Tube & copper wire & Tin.

The large collector at the bottom should ensure that flushing is only required now and then. The automatic air vent should be guaranteed not to leak and cannot be closed.

There should be a special constructed air chamber to protect the valve mechanism from dirt. Sufficient volume to take care of pressure fluctuations. Air Separation via centrifugal force is not acceptable Large capacity collection chamber should reduce the need for frequent draining. A drain valve is installed at the bottom of the tube for flushing out the dirt. All connections, fittings and heads shall be of carbon steel. The Design and manufacturing of the unit should be in accordance with 97/23/EC.

The unique tube element should cause a local change of the flow in the steel housing, from turbulent to laminar. Because of this, microbubbles of air are removed from the fluid and dirt particles will sink down. The microbubbles are collected in the air chamber and released to the environment by means of an automatic air vent. The dirt particles are collected at the bottom of the separator and can be released manually during operation. A good flow-through of the piping should be guaranteed.

Testing

All water piping shall be tested to hydrostatic tests pressure of at least two times the maximum operating pressure, but not less than 7Kg/cm2g for a period of not less than 24 hours.

All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Consultant/Employer. Piping repaired subsequent to the above pressure shall be retested in the same summer. Piping may be tested in sections and such sections shall be securely capped.

Cleaning Piping

After piping system has been tested and proved tight, the Contractor shall clean piping system of dirt, scale, oil, grease, waste & other foreign substance, which may have accumulated during process of installation. Strainer, screens shall be removed, cleaned and replaced after cleaning process and cleaned after flushing process.

Painting

After all piping has been installed, tested and run for at least two weeks it shall be coated with primer coat and synthetic enamel paints of approved shades as per the colour code. The direction of fluid in the pipes shall be visibly marked with paint.

12.0 AIR MOVING EQUIPMENTS:

12.1 FLOOR MOUNTED DOUBLE SKIN AIR HANDLING UNIT/s-

Air Handling Units shall consist of fan section, coil section, Pre-filter section, and Post-filter section & will have the construction as described below -

Air handling units will be in double skin construction fabricated out of Aluminum Extruded section and 43 mm thick Double skin panels.

Aluminum sections should have double walled rib having a groove for the gasket on the panel side face and plane surface on internal face. Panel side face should also have additional plane face available for stick on type gasket to facilitate the fixing of additional gaskets in future if required. Units will be supplied with round gasket in solid / tubular construction fixed in the groove. Gasket will be made out of PVC / Synthetic rubber. Extruded section will be having scratchproof anodized finish. The extruded frame structure will be formed using couplers made out of glass filled nylon, (approx. 30% glass and 70% nylon).

AHU Casing-

Double skin panels will be fabricated out of best quality G. I. 0.8mm (22G) Powder coated sheet on outer side and 0.63mm (24G) plane G. I. Sheet on inner side. Polyurethane foam of density not less than 36 Kg./Cu. M. will be sandwiched between inner and outer sheet. The panels will be fixed on Al. Extruded section in such a manner that fixing screw head does not project on outer face on the panel and sharp end of the screw does not project inside the unit through double walled rib. The screw hole on panel will be blocked with Nylon sleeve with cap. The panels shall be 25 mm thick. The screw cavity on panel will be blocked with nylon sleeve with cap.

Drain tray will be fabricated out of SS sheet having thickness not less than 1.2mm (18 G). The tray will have sufficient depth and proper size drain connection. The tray will be insulated from outside with nitrile rubber foam sheet having thickness not less than 20mm. The rollars in nylon construction will be provided below the coil for easy removal of coils in the AHUs of areas dealing with powder. Gasket sleeves at chilled water header outlet will be provided in such a design that the same does not obstruct the pulling of coil at the time of removal.

Filter section will have rigid construction filter frame fabricated out of GI sheet to house required size filters. The filters will be in flange type construction having GI casing.

Blower section will consists of extruded sections of proper size to facilitate the mounting of fan and motor bracket. Direct contact of fan base frame and AHU casing will be eliminated through vibration isolator. Also flexible connection will be provided at the fan outlet. Suitable panel of blower section will be provided with hole for cable entry with required arrangement to cover the sharp edge GI sheet. If required, a proper size box cover will be provided on cable entry location. A provision for earthling will be provided on mainframe near the cable entry hole.

Inspection doors at required location will be provided with elegant design hinges made out die cast Aluminum alloy. Two or more number of hinges per door will be provided depending upon the size of the door to provide required rigidity to the door panel. One or

more number of door handles will be provided with can type tightening arrangement. The handle and can will be made out of filled nylon having galvanized iron spindle. The inspection door for blower section will be provided at such a location that the motor and drive package and fan bearing can be assessed for easily maintenance. An additional guard made out of GI wire mesh of required strength will be provided at inner side of blower section inspection door. A limit switch / door switch covered electrical terminal will be provided to facilitate the door inter locking with fan operation. An inspection glass fitting having the transparent element on both side of the panel with a common gasket sleeve between two elements will be provided on blower section inspection door to facilitate inspection of drive package in running condition without opening the inspection door. The inspection doors of the sections accommodating filters will be of sufficient size to take care of filter removal.

Necessary arrangement with required plastic / nylon fittings will be provided at required locations to facilitate the mounting of temperature Humidity & pressure sensors as per requirement of BMS vendors.

Properly designed nipples will be provided at required locations to facilitate the connection of manometer tubes / pressure transmitter.

The entire AHU assembly will be mounted on a common skid fabricated out of HDG MS channel of required size. The skid will be secured with AHU frame structure through threaded fasteners. The skid will be duly painted after fabrication with the best quality rust preventive primer followed by tow coats of enamel paint.

All nut bolts, sheet metal screws, fasteners will be Zinc / Nickel plated having resistance against rusting.

Cooling Coils-

The cooling coils shall be fabricated out of copper tube having OD not less than 12.5 mm and Aluminum fins spaced @ 12 fins / inch. Aluminum fins & copper tubes will have foam bond provided by hydraulic expansion method at the high pressure above yield point. The capacity of the coils shall be as required under the schedule of equipment. Velocity of air across coil face shall not exceed 500 FPM for 4 Row coil and 600 FPM for 6 Row coil. The bottle shaped steam humidifier along with sensors & solenoid valve & strip heater of capacity as mentioned in the BOQ shall be provided to meet inside conditions. The Coils & Fittings are suitable for 20kg/cm² Pressure.

Fan-

Fan wheels and scrolls shall be fabricated from best quality sheet steel. The fan wheels shall be of the backward curved / Plug type enclosed in housing and mounted on a solid shaft.

Fan scrolls shall be fitted with die formed side sheet streamlined inlet and to ensure smooth airflow into the fan.

Filters-

Pre-filters shall be HDPE washable types with 2" thickness with filtration level of mentioned in drgs. & efficiency of 90%. The pre-filter section will be located on suction side of the filters & Post-filters as per drawing.

Fan motors-

Fan motors shall be 3 phase, sq. cage, and T.E.F.C. induction type, together with starters, specified in "ELECTRICAL ITEMS" separately. The motors shall be capable of high initial starting torque requirement of fans & suitable for VFD application where ever specified.

Accessories-

Air Handling Units shall be complete with all accessories & shall also include the following-

a. Shut-off valves, diverting valve, manual air vents, drain valves for cooling coils and drain piping.
b. Vibration eliminators and flexible connections.
c. Supply & return water with dial type thermometer having a range of 0 to 50°C.
d. 100 mm dia. pressure gauges (0 to 7 Kg/Cm²) with 10 mm of Niddle valve at inlet and outlet.
e. Automatic chilled water flow control with modulating valves.

(All the above specified accessories are quantified in BOQ and shall be measured separately).

The exterior surface of air handling unit/s shall be powder coated.

12.2 DOUBLE SKIN CEILING SUSPENDED DUCTABLE UNIT/s

Ductable Units shall consist of fan section, coil section, Pre-filter section and will have the construction as described below-

Ductable units will be in double skin construction made out of Aluminium Extruded section and 25 mm thick Double skin panels.

Unit Casing

The framework of the casing will be in extruded Aluminium construction having 15 to 18 micron thick anodized finished. Double skin panels will be fabricated out of best G. I. 0.80 mm (22G) Powder coated sheet on outer side and plain G. I.0.63mm (24G) Sheet on inner side. Polyurethane of density not less than 36 Kg./Cu. M. will sandwiched between inner and outer sheet. The panels will be fixed on Al. Extruded section in such a manner that fixing screw head does not project on outer face on the panel. The screw hole on panel be blocked with Nylon sleeve with cap. The insulation shall be 25 mm thick. The screw cavity on will be blocked with nylon sleeve with cap. Drain tray will be fabricated out of SS sheet thickness not less than 1.2mm (18 G). The tray will have sufficient depth and proper size drain connection. The tray will be insulated from with nitrile rubber foam sheet having not less than 20mm.

Filter section will have rigid construction filter fabricated out of GI sheet to house required filters. The filters will be in flange construction having GI casing. Suitable panel of section will be provided with hole for entry with required arrangement to cover sharp edge G. I.

sheet. If required, a proper box cover will be provided on cable entry. A provision for earthing will be on mainframe near the cable entry hole.

Inspection doors at required location will be with elegant design hinges made out die Aluminium alloy. Two or more number of hinges door will be provided depending upon the size the door to provide required rigidity to the panel. One or more number of door handles be provided with can type tightening.

The handle and can will be made out of filled having galvanized iron spindle. The door for blower section will be at such a location that the motor and package and fan bearing can be assessed for maintenance. An additional guard made out GI wire mesh of required strength will be at inner side of blower section door. A limit switch / door switch electrical terminal will be provided to the door inter locking with fan. An inspection glass fitting having the element on both side of the panel with common gasket sleeve between two elements will provided on blower section inspection door to inspection of drive package in running without opening the inspection door. The doors of the sections accommodating will be of sufficient size to take care of removal.

All nut bolts, sheet metal screws, fasteners will Zinc / Nickel-plated having resistance against.

Cooling Coils

The cooling coils shall be fabricated out of tube having OD not less than 10 mm and fins spaced @ 12 fins / inch. Aluminium & copper tubes will have foam bond provided hydraulic expansion method at the high pressure yield point. The capacity of the coils shall as required under the schedule of equipment. Velocity of air across coil face shall not exceed FPM for 4 Row coil and 600 FPM for 6 Row coil. The Coils & Fittings are suitable for 20kg/cm² Pressure.

Fan scrolls shall be fitted with die formed side streamlined inlet and to ensure smooth into the fan.

Filters

Pre-filters shall be HDPE washable types with 2" with filtration level of 10 micron and of 90%. The pre-filter section will be on suction side of the filters.

Fan motors

Three Phase: Fan motors shall be sq. cage, and T.E.F.C. induction type, together with starters, specified in “ELECTRICAL ITEMS” separately. The motors shall be capable of high initial starting torque requirement of fans & suitable for VFD application where ever specified.

Single Phase: Fan motors shall be lug mounted, PSC type. The motor shall be capable of high initial starting requirement of fans.

12.3 TREATED FRESH AIR UNIT WITH OR WITHOUT COIL

SCOPE

The scope of this section comprises of the supply of double-skin "Dedicated Outdoor Air Systems" conforming to the specifications below.

The manufacturer or their principals shall have at least 10 years of designing and manufacturing experience directly in the product i.e. energy recovery devices, with a two tier, two air stream unit design in India. The heat recovery wheel and box should be from the same manufacturer. The manufacturer of the wheel should have manufacturing units in India.

The unit hereafter is referred to as HRU.

TYPE

The DOAS units shall be two stream units in double skin construction, comprising of supply air section, return air section and Heat Recovery Section. The supply air section shall include the following sections as defined in the Bill Of Quantities: Fresh Air Inlet Damper, G3 pre-filter, Cooling Coil Section, Inspection Section, Sensible Heat Recovery Wheel, Fan section comprising Supply Air fan and motor.

The Return Air section shall include the following sections : Return Air inlet damper, G3 pre-filter, Fan section comprising of Exhaust Fan with motor. Option shall be available for Digital Air Flow Measurement, Pressure Transmitter and Filter Cleaning Alarm if required in the Bill of Quantities.

CAPACITY

The HRU units shall be of such capacities and static pressures as mentioned in the Bill of Quantities.

CASING

The units shall be made of extruded Aluminium hollow profile frames. The profile box size shall be of minimum 30 mm for capacities upto 22000 CMH, such that it provides the required mechanical strength and rigidity. The unit should be devoid of any welded construction and should be of cabinet type. All the frames should be assembled using pressure die cast aluminum joints/corners to make a self-supporting frame. The Casing leakage shall be in accordance with relevant EUROVENT standard that is CLASS B.

The panels shall be of double skin construction with both inner and outer steel sheets being minimum 0.8mm thick pre coated & plasticized. 25 mm thick fire retardant, fibre glass insulation shall be sandwiched between the sheets. The fibre glass density shall be 48 kg/m3. Materials emitting toxic gases like PUF shall not be used for insulation. The Inspection and access panels shall be hinged type. The hinges shall be casted, powder coated Zinc alloy. Flushed Locks and Handles shall be of galvanized steel. Other panels will be screwed on to the frame with sealant and soft rubber gasket thus making the joints air tight . All screws used for panel fixing shall be covered with PVC caps.

Special hollow gaskets and seals shall be used on inspection doors and to create separation between the airstreams to ensure negligible air leakage and mixing The entire casing shall be mounted on electro galvanized channel frame work with level screws. Condensate drain pan shall be fabricated from 18 g GSS/SS construction. Option for fire resistance Class of A-30 shall be available, if required in the Bill of Quantities

SUPPLY AIR SECTION

The supply air section shall comprise of the following:

FAN SECTION

The fan shall be centrifugal forward curved or backward curved, double inlet double width type. The impeller and the fan casing shall be made of hot galvanized sheet steel.

The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 85db. Fan housing and motor shall be mounted on a common galvanized steel or aluminum block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and TFA outlet should be provided.

MOTOR AND DRIVE

Fan motor shall be energy efficient and suitable for 415 ± 10% volts, 50 cycles, 3 phase squirrel cage, totally enclosed fan cooled with IP – 55 protection. Motor shall be designed for for quiet operation . Drive shall be provided through belt – drive arrangement. Belts will be of oil resistant type.

FILTER SECTION

The filter section shall be normally designed for deep folded disposable synthetic prefilters for Class EU3.The filter elements shall be mounted on rails and shall be easily pulled out for replacement. The rails shall be provided with efficient gaskets to minimize the risk of leakage .If mentioned in the Bill of Quantities the section shall be designed to include filters upto class EU 8.

DAMPER SECTION

Damper section shall contain a built in damper of aluminum profile with leakage class III.
The damper blades shall be connected with plastic gear wheels with a gasket of silicon rubber to produce tightness between the blades.

COOLING COIL SECTION WITH COIL – AS MENTIONED IN BOQ

The cooling coil section shall be available in two options as below, and shall be selected based on the details mentioned in the Bill Of Quantities.

i. Upto 8 row deep - long
ii. Upto 4 row deep – short

The cooling coil section shall be suitable for both DX and chilled water type. Drain pan made out of 18g GSS/SS shall be provided. The Coils & Fittings are suitable for 20kg/cm² Pressure.

INSPECTION SECTION

The Inspection section shall be for inspection of other functional sections. It shall be available in two options; long and short version and shall be selected as defined in the Bill of Quantities.

RETURN AIR SECTION

The return air section shall comprise of above sections. The specification for this section shall remain same as defined.

The Desiccant : The desiccant should be water molecule selective and nonmigratory.

The desiccant should be molecular sieve, so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapour molecules.

The desiccant, of sufficient mass which should not be less than 5 kg per 1000 cfm of air, should be coated with non masking porous binder adhesive on the aluminum substrateso as to allow quick and easy uptake and release of water vapour. A confirmation has to be provided by manufacturer of wheel to this effect. A matrix with desiccants impregnated in non metallic substrates, such as synthetic fibre, glass fibre, etc. will not be accepted.

The rotor/wheel matrix shall have equal sensible and latent recovery.

The weight of desiccant coating and the mass of aluminum foil shall be in a ratio so as to ensure equal recovery of both sensible and latent heat over the operating range. Accordingly, a rotor matrix which has an etched or oxidised surface to make a desiccant on a metal foil and results in insufficient latent recovery and hence unequal recovery, or a rotor matrix made from desiccant integrated in a synthetic fibre matrix which result in insufficient sensible recovery, high rotation speed, and unequal recovery, will not be accepted.

Rotor : With optimum heat and mass through matrix formed by desiccant, of sufficient mass, coated on an aluminum foil, the rotor should rotate at lower than 20 to 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals. The rotor shall be made of alternate flat and corrugated aluminum foil of uniform width. The rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media which shall not get cracked, deformed etc. due to change of temperature or humidity. The rotor having a diameter upto 2800 mm shall have spokes to reinforce the matrix. From 2000 mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.

The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.

Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2000 mm in diameter.

The surface of the wheel/rotor should be highly polished to ensure that the vertical run out does not exceed + 1 mm for every 1 metre diameter, thereby ensuring, negligible leakage, if labyrinth non contact seals are provided, and minimal drag, if contact wiper seals are provided.

The radial run out also shall not exceed + 1 mm for every 1 meter diameter, thereby

minimising the leakage/drag on the radial seals, and minimise the fluctuation in the tension of the drive belt.

The number of wraps (of alternative corrugated and flat foil) for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.

The rotor shall be a non clogging aluminum media, having a multitude of narrow aluminum foil channels, thus ensuring a laminar flow, and will allow particles upto 800 microns to pass through it.

The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.

The Cassette / casing:

The recovery wheel cassette/casing shall be manufactured from tubular structure to provide a self supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt.

The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow minimising the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination to less than 0.04% of that of the exhaust air concentration.

The face and radial seals shall be four (4) pass non contact labyrinth seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring infinite life of the seals.

HEAT RECOVERY SECTION: (SENSIBLE WHEEL)

The Heat Recovery section shall include sensible wheels and shall have minimum recovery of 75 % of sensible heat. Necessary computerized selection of the wheel should be provided along with the bid to justify the same.

The wheel shall be made of pure aluminum foil. The cross contamination between the two air streams shall be nil and leakage less than 0.04%. The vertical and radial run of the wheel shall be less than 1 mm per meter of diameter. The wheels shall have non contact labyrinth seals for effective sealing between the two air streams.

Detailed specification for the wheel shall be as per section i.e. “HEAT RECOVERY WHEEL (Sensible Wheel)”

Heat Recovery Wheel (Sensible) specifications:

Rotor/wheel matrix shall be of —

(a) The substrate: The substrate or wheel matrix should be only of pure aluminum foil so as to allow:

i) quick and efficient uptake of thermal energy.

ii) sufficient mass for optimum heat transfer
iii) maximum sensible heat recovery at a relatively low rotational speed of 20 to 25 rpm.

Non metallic substrates made from paper, plastic, synthetic or glass fibre media, will therefore, not be acceptable.

The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.

The wheel has to be certified as per DIN EN ISO 846 with 0% fungal and bacterial growth at 95% Relative humidity and above.

Fire rating:

NFPA - 90A certification with 0% for Flame spread classification should be confirmed by manufacturer.

Pressure drop:

The pressure drop across the rotary heat exchanger shall not exceed 0.1 inch for every 100 FPM face velocity, or part thereof, for the minimum stated / required latent recoveries / efficiencies

The Cassette / casing:

The sensible recovery wheel cassette/casing specification shall be as in of (d) above.

12.5 FAN COIL UNIT 4 PIPE SYSTEM

General

Fan coil units shall comply with quality standard IS09001/9002 and be 'type' tested. The Contractor shall submit the make and type of each fan together with the 'type' test certificate for the Architect/Consultant's approval.

Fans, filters, cooling coils, heating coils, motors, thermal and acoustic insulation shall comply with the appropriate sections of this General Specification and the following requirements:-

Fans shall be of the Double Inlet Double Width (DIDW) forward curved centrifugal or tangential flow types and shall be of aluminium.

Air filters shall be of HDPE type with an efficiency of not less than 50% when tested in accordance with BS EN779.

Motors shall be quiet running and have sleeve or hall bearings factory lubricated for life. Motor windings and electrical components shall be impregnated or protected to avoid trouble from condensation. The fan motor shall be of the single phase permanent split capacitor type provided with three speed tapped windings.

All fan coil units capacity and air flow rate shall be selected based on the performance of the units at medium fan speed.

In selecting the fan coil units, allowance shall he made fur the actual resistance imposed on the air flow of the units due to ducts and grilles. The added resistance is to be applied to all fan coil units whether shown to have ducts connected or not. and shall be taken as not less than 50 Pa external to the unit.

The thermal, volumetric and acoustic performance of fan coil units shall meet the requirements indicated and testing and rating shall be in accordance with BS 4856.

Casings

Casings shall be of G.I. sheet metal with thickness not less than 1,0 mm suitably stiffened to minimize drumming and vibration and shall be protected against corrosion and finished inside and outside with stoved primer. All corners shall be rounded off without sharp edges. Casings shall be lined with material to act as both thermal and acoustic insulation which shall comply with the relevant specifications. Casings shall include space for pipe work connections and valves, and there shall be ready access to the fan and motor filter, damper, drain pan, pipe work connections and valves, for maintenance purposes.

The motor and fan shall be mounted on a detachable mounting chassis that can be removed from the fan coil enclosure as one assembly (with extended cables) to facilitate fan and motor cleaning. It shall then also be possible to remove the fan impeller scroll casing in order to properly clean the fan blades. Fan and motor assemblies shall be complete with neoprene rubber anti-vibration mountings.

COIL – COOLING & HEATING (4 PIPE SYSTEM)

Cooling coils shall be minimum two-row and shall include an air vent cock and drain valve,

The chilled water cooling coil shall be ARI certified and constructed from seamless copper tubes mechanically bonded to aluminium fins.

Each Coil shall be provided with motorized 2-way solenoid control valve and isolation valves, flexible pipe connectors complete with union joints to facilitate removal of the entire unit shall be provided. The connector shall be stainless steel braided polymer tubing limited to 300 mm long and suitable for the system pressure,

Working pressure of coils shall suit specific requirements.

All units shall include an easily removable filter capable of treating the total air volume. Filters shall, unless otherwise specified be washable. It shall be supported in stiff aluminium/stainless steel with drawable frame.

Drain pans shall be made of one piece stamped stainless sheet steel with no wold and protected against corrosion, or made of reinforced glass fibre materials insulated with a minimum of 13 mm thick flexible closed cell elastomeric insulation. Drain pans shall be large and deep enough to collect all condensate from the coil, return bends and pipework connections. The pan shall be removable and have a slight fall to the drain connection. For units whose loads include a high proportion of latent cooling the fall to the drain point and the size of the drain connection shall be adequate to deal with the condensed moisture. The coil & all fittings selected should ensure that the assembly can sustain working / static pressure of 300 PSIG (20.6 kg/cm^2).

Arrangement of Units

The arrangement of units (e.g. wall, floor or ceiling mounted), the position of inlet and outlet grilled if any, the need for G.I. sheet metal casing etc. shall be as indicated.

Controls, Dampers and Grilles

Fan coil units shall have a combined room temperature sensor complete with 3-specd controller and heating/cooling mode selector as specified. Where indicated they shall have connections for both fresh and recirculated air and shall include a damper which shall be adjustable to give up to 25% of the fan capacity drawing from the fresh air source. Outlet grilles shall be capable of adjusting the direction of airflow without adversely affecting pressure drop. On floor mounted units, supply grilles shall be on the top of the unit.

Noise level

The noise data provided shall include an octave band analysis of the sound power level of each unit when operating al its full or the stated design speed. The Noise level in the Room should not exceed 32 DBA.

The entire FCU will be powder coated and will be provided with filter box. The FCU will also be provided with auxiliary drain pan (sand witched insulated). The drain connection will be made from both the drain points of main drain tray and the auxiliary drain pan.

12.6 WATER BASED CASSETTE TYPE IN DOOR UNITS

EVAPORATING UNIT

The cooling coils shall be made of Copper Tubing having extended alu. fins. The tubes shall be mechanically expanded for positive bonding between tubes and fins. The cooling coils circuit shall be fed with chilled water from the header through valve and the flow is modulate by modulating control valve with respect to load. The blower shall be statically and dynamically balanced and designed for silent operation at required airflow rates against required static pressure. The filters shall be washable synthetic media type arranged for convenient cleaning and replacement. In built Drain pump should be provided along with indoor unit for proper drainage of condensed water. The drain pan shall be fabricated out of heavy sheet steel, insulated with 1/4" expanded polyethylene sheet. The casing shall be of heavy gauge G.I., duly powder coated for weather protection.

CONTROLS AND INTERLOCKING

Electrically/electronically operated controls shall be provided with all components, auxiliary relays, capacitors including wiring for controls and interlocking.

DRAIN PIPING

Condensate from the evaporator unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan.

Drain piping shall be made of 1.1/4" dia / 2" dia rigid PVC pipe of with water tight threaded connections, leading from the room unit to a suitable drain point. Complete drain piping shall

be made leak proof and water tight by means of precise installation and the use of leak proof sealant / adhesives. Insulation of drain piping should be carries out with nitrile rubber.

13.0 VENTILATION FANS:

The design, materials, construction, manufacture, inspection, testing and field performance of the fans shall comply with all currently applicable international / national codes / safety regulations. Nothing in this specification shall be construed to relieve the VENDOR of his responsibility. In particular the equipment shall conform to latest editions of all applicable codes and standards listed below.

AMCA-201 - Fans and systems - Application guide
AMCA-203 - Field performance measurement of fan systems
AMCA-210 -Laboratory Methods of testing Fans for Aerodynamic performance rating.
AMCA-2404 - Drive arrangements for centrifugal fans
ASME Section-V - Code for Non Destructive examination
ASME Section-IX - Welding and brazing procedure and welder's qualification
BS:848, Part-1 - Fans for general purposes - Methods of testing performance
BS:4675, Part-1/ ISO-2372 - Mechanical vibrations in rotating and reciprocating machinery
VDI-2056 - Criteria for assessing mechanical vibrations of machines
IS:816-Code of practice for use of metal arc welding for general construction in mild steel
IS:823 - Code of practice for manual metal arc welding of mild steel
IS:1353(Grade C) - Black Hexagonal bolts, nuts and lock nuts and black hexagonal screws
IS:210 -Specification for grey iron castings
IS:2062 -Structural steel (standard quality) for general structural purposes
IS:2074 -Specifications for Red Oxide Zinc chrome, Priming Ready mixed paint air drying
IS:325 - Three phase induction motor
IS:4894 - Specifications for centrifugal fans
ISO:1940 -Balance quality of rotating rigid bodies (static & dynamic of rotary parts)
IS : 4029 - Guide for testing three phase induction motor
IS-3588 -Specification for Electric Axial flow fans
IS-2312 -Propeller Type A.C. Ventilation Fans

BS-848 -Methods of performance test for Fans
IS-1367 -Technical supply conditions for threaded fasteners.
IS-737 - Wrought aluminium and aluminium alloy sheet and strip (for general engineering purposes)

13.1 SINGLE SKIN CABINET TYPE UNIT (FOR EXHAUST & FRESH AIR)

Construction

Floor mounted exhaust unit will consist of blower section with return air cut out and ventilation units will consist of filter section and fan section with S. A. cut-out. Units will have the construction as described below-

Casing

Units will be in single skin construction with all the **features similar to double skin construction units.** Units will be fabricated out of Aluminium Extruded section and GI panels.

Extruded aluminium profiles will be duly anodised as per industrial standards (15 to 18 Micron anodising). The panels will be in 1.8 mm thick GI construction duly coated with pure epoxy powder / liquid polyurethane paint for the highest production against humid or polluted weather. The panels will be secured properly on the frame structure providing proper gasket between panel and frame.

Filter section (for ventilation units) will have rigid construction filter frame fabricated out of GI sheet to house required size filters. The filters will be in flange type construction having GI casing. Threaded inserts / nuts duly nickel-plated will be pre-fixed on filter frame for securing the filters.

Blower section will consists of fan base frame made out of extruded sections of proper size to facilitate the mounting of fan and motor. Vibration isolators will be provided to eliminate direct contact of fan base frame and AHU casing. Also flexible connection will be provided at the fan outlet. Suitable panel of blower section will be provided with hole for cable entry with required fitting. If required, a proper size box cover will be provided on cable entry location. A provision for earthing will be provided on mainframe near the cable entry hole.

Inspection doors at required location will be provided with elegant design hinges made out die cast Aluminium alloy or glass filled nylon. Two or more number of hinges per door will be provided depending upon the size of the door to provide required rigidity to the door panel. One or more number of door handles will be provided with cam type tightening arrangement. The handle and cam will be made out of glass filled nylon having galvanised iron spindle.

The inspection door for blower section will be provided at such a location that the motor and drive package and fan bearing can be assessed for easily maintenance. An additional guard made out of GI wire mesh of required strength will be provided at inner side of blower section inspection door. A limit switch / door switch with covered electrical terminal will be provided to facilitate the door inter locking with fan operation.

The entire unit will be mounted on a common skid fabricated out of Hot Deep Galvanised MS channel of required size. The skid will be secured with AHU frame structure through threaded fasteners. The skid will be duly painted with the best quality rust preventive primer followed by tow coats of enamel paint.

All nut bolts, sheet metal screws, fasteners will be Zinc / Nickel-plated having resistance against rusting.

Fan

Fan wheels and scrolls shall be fabricated from best quality GI sheets. The fan wheels shall be of the forward / backward curved type enclosed in housing and mounted on a solid shaft. The fan shaft will be coated with suitable rust preventives after the final assembly. Backward curved impellers (wherever required) will be in galvanized iron or epoxy painted construction. Fan scrolls shall be fitted with die formed streamlined inlet to ensure smooth airflow into the fan.

Filters

Flanged type filters shall be HDPE washable types with required thickness and filtration level as per requirement.

Fan motors

Fan motors shall be 3 phases, sq. cage, T.E.F.C. IP 55 Class F insulation induction type. The motors shall be capable of high initial starting torque requirement of fans.

All the single skin cabinet type unit/ ventilation fans shall be AMCA (Air Movement and Control Associates Incorporation of USA) certified for air & noise performance.

13.2 CENTRIFUGAL SMOKE SPILL TYPE EXHAUST FANs – IF APPLICABLE

The Section should consist of Centrifugal type smoke spill fans with statically and dynamically balanced. The fan should have belt driven arrangement with external motor fixing arrangement suitable for VFD Application. The cabinet is to made one of heavy gauge of Galvanized sheet metal.

The unit should comprise of inlet grille, outlet flange motor to operate on high temperature. Fan should fulfill performance criteria for 280 ºC for 30 Min.

13.3 TUBE AXIAL FANs-

IMPELLER

The impeller shall be of die cast aluminium alloy with integrally cast aerofoil sectioned blades and hub. Impeller shall be fixed to motor shaft by a thrust plate and bolt reverse to direction of rotation, in addition to key lock. The critical speed of impeller shall be minimum 1.5 times of the operating speed. The impeller shall be statically and dynamically balanced to G 6.3 grade as per ISO: 1940.

CASING

Casing shall be of 2mm thick MS for impeller dia up to 600mm and 2.5mm thick MS for impeller dia above 600mm. Casing shall have flanged connection on both ends for ducted application. It shall be provided with suitable supports. Access door shall be provided in the casing for easy access to motor and impeller. Suitable arrangement for mounting of motor shall be provided.

GUIDE VANES

In case of vane axial fans guide vane shall be provided on the discharge side.

GUARDS

Suitably designed guards shall be supplied.

The fan motor construction should be of class H type & Suitable for VFD Application.

The fan shall be hanged from slab accordingly suspension rod are to be designed to take care of fan dynamic load as well as fire retardant flexible connection has be provided along with necessary fittings and accessories.

The fan requires rated temperature of 250ºC for a duration of 120 Minutes.

All the axial fans shall be AMCA (Air Movement and Control Associates Incorporation of USA) certified for air performance.

13.4 HOT AIR EXHAUST FAN (SISW CENTRIFUGAL FAN)

Backward curve SISW centrifugal type fan for kitchen hot air exhaust along with drive package and base frame and of should be of following specifications.

Casing: All welded construction with all sizes. All sides' plates are braced for rigidity and strength with heavy steel angle. On higher pressure type fans, class 2 and class 3, extra heavy gauge side plates and reinforcing angles provide the rigidity required for trouble free operation.

Bearings & Bearing Supports: Self aligning, antifriction ball bearings stand on fans. Special applications will have special consideration. Sleeve bearings can be used for sizes from 17/16" and larger, for extremely quite installations. Bearing supports should be designed for adequate stiffness to prevent vibration and with minimum obstruction to air flow. Fabricated steel plate independent bearing pedestals are to be furnished on class 3 arrangement fans. The bearings should be considered for 100°C air temperature & accordingly grease to be filled.

Shafts: Supplied from ground and polished steel, held to close tolerances, with diameters selected for speeds well in excess of the maximum rated speed of each fan size.

Outlet & Inlet Connections: Slip joints should be supplied as standard for class 1 fans and for class 2 and 3 fans have flanged outlet as standard with optional flanged inlets.

13.5 MIXED FLOW FANS:

GENERAL

WORK INCLUDED

Belt Drive Mixed Flow Inline Fans

RELATED SECTIONS

All sections, drawing plans, specifications and contract documents.

REFERENCES

MCA 99, "Standards Handbook"
ANSI/AMCA Standard 204-96, "Balance Quality and Vibration Levels for Fans"
ANSI/AMCA Standard 210-99, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"

AMCA Publication 211-05, "Certified Ratings Programme - Product Rating Manual for Fan Air Performance"
AMCA Standard 300-96, "Reverberant Room Method for Sound Testing of Fans"
AMCA Publication 311-05, "Certified Ratings Programme - Product Rating Manual For Fan Sound Performance"
UL Standard 705, "Power Ventilators"

Fans shall UL listed as "Power Ventilators for Smoke Control Systems" for a minimum of 250 Deg C for a minimum of 2 Hours of operation.

SUBMITTALS

Provide dimensional drawings and product data on each mixed flow inline fan.
Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
Provide outlet velocity of axial fans and both inlet and outlet sound power readings for the eight octave bands.
Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.5 of this specification

QUALITY ASSURANCE

Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA seal for air and sound performance.
Classification for Spark Resistant Construction Conform to AMCA 99.
Each fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204-96, while operating at the specified fan RPM. The vibration signatures shall be taken on each bearing in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 0.15 in/sec peak velocity, filter-in as measured at the fan RPM. Report shall be provided at no charge to the customer upon request.

DELIVERY, SOTRAGE, AND HANDLING

Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions.
Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

PRODUCTS

GENERAL

Base fan performance at standard conditions.
Fans selected shall be capable of accommodating static pressure and flow variations of +/- 15% of scheduled values.
Each fan shall be belt drive in AMCA arrangement 9.

Fans are to be equipped with lifting lugs.
After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Polyester Urethane Paint, electrostatically applied and baked. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

FAN HOUSING AND OUTLET

Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of Polyester Urethane Paint, electrostatically applied and baked
Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
All mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge.
Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Bearing life shall not be reduced below specified level in different configurations.
An access door shall be supplied for impeller inspection and service.

FAN IMPELLER

Fan impeller shall be mixed flow design. The impeller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of Polyester Urethane Paint, electrostatically applied and baked.
The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

FAN MOTORS AND DRIVE.

Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be UL listed and can be Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC).
Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class.
Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
Bearings shall have extended lube lines with Zerk fittings to allow for lubrication.

EXECUTION

INSTALLATION

Install fans systems as indicated on the contract drawings.
Install fans in accordance with manufacturer instructions.

13.6 DIRECT *TWO STAGE* BLOWER TYPE RIGID MEDIA EVAPORATIVE COOLING SYSTEMS

GENERAL

The Evaporative Cooling Machine shall be self contained and will consist of the following component parts as listed below. The entire unit must be **WEATHERPROOFED** and **CORROSION PROTECTED** as specified. The unit shall have a horizontal monoblock self priming pump assembly to provide recirculated tank water and a pressurized flow via a piping system for proper pad and media water distribution. The unit shall be factory fabricated and will include

BLOWER SECTION

The blower section of the unit will consist of single fan and motor assembly mounted on a common base frame. Required distance piece and a flexible connection will be provided at the outlet of the fan.

The fan blower assembly shall be isolated from main casing through rubber block type vibration isolators. A sufficient size manhole will be provided on both the end panels of the blower section. Appropriate size slide rail will be provided for suitable motor. Drive pulleys will be statically and dynamically balanced, the belts will be Fenner Make.

The side and top panels of the blower section will be insulated from inside with at-least 12 mm thick expanded polyethylene / 25 mm expanded polystyrene. However the bottom panel of the blower section will be insulated from the outer side.

The fan shall have a capacity not less than the one specified in BOQ and shall be constructed and rated based on delivery against the rated static pressure with the media and filters in place. The blower housing will of MACHINE **MADE ROLLFORMED** pittsburg joint construction and the drive will be provided by a motor of adequate capacity. The motor plate will be constructed out of 12 G MS or heavier metal with slotted holes which permit belt adjustment in both the directions. The material used will be 16 G GI. The outlet Velocity of the blowers will be kept low.

INDIRECT FANS

The indirect fans shall be fitted with aerodynamically shaped blades, balanced for quite operation, TEFC motors will be used. The fan housing shall be 3 mm FRP with inlet to the fan of a smooth bell shaped venturi. Fan outlets shall be fitted with bird screens if no ducting is attached to the discharge of the fan.

INDIRECT EVAPORATIVE SECTION

Will have cooling coil of specified efficiency made with 12.7 mm copper pipe with

aluminum fins, seamless copper headers and housed in a sturdy galvanized casing.

DIRECT EVAPORATIVE SECTION

The wet section will have 16 G GI Tank with folded construction with the bolted openable sides in 16 G GI sheet. The section will be of welded construction. 300 mm thick Cooling pads will be provided designed @ 2.5 m/s to give 90% adiabatic efficiency. 2mm thick FRP specially fabricated header will be provided for the water distribution using 20 mm PVC perforated piping. All wet sections will include 5 layer 30 micron Aluminum Wire mesh filters of 50 mm thickness including the mounting channels for the same. 15 mm Brass Bleed off cock, 20 mm heavy duty Brass Float. PVC drain/overflow and bleed off outlet are standard on all wet sections.

13.8 AIR CLEANING UNITS FOR KITCHEN HOOD EXHAUST – SCRUBBER

Unit to be constructed in modular construction by using minimum 16G zinc coated steel.

All the welds and the finished area of welds are treated with corrosion & rust inhibiting coating to assure long life cabinet to be finished & completed with a durable industrial grade semi glass, backed on enamel not less than 0.3 MM Thk. All doors are gasketed to prevent air & water leakage.

Sections

Pre Filter: - Metal mesh or perforated plate type prefilter to capture of oversize objects and agglomerated mists.

Electrostatic Air Cleaner Module:-

Electrostatic Air cleaners section capable to remove extremely small particulate the working of electrostatic air cleaner should be as under.

“As air enters filter, the particles pass through a high intensity electrical field that imparts an electrical change to the particles. The charged particles should range in size from 0.01 micron to 10 micron”

The charged particles pass through a series of alternately charged collector plates. The particles should repelled by plate with the same polarity and attracted to plates with opposite polarity.

Ionizing-Collecting Cells:

Ionizing-Collecting cell(s) shall be of one-piece construction 13.38” (340mm) deep in direction of airflow. All support framing, end plates and ionizer ground electrodes shall be 0.090 inch (2.2mm) thick aluminum. Both repelling and collector plates shall be 0.032 inch (0.8mm) thick aluminum alloy material, rigidly retained in place with tubular spacers and tie rods. Each plate shall be corrugated, perpendicular to airflow direction. Spacing between plates shall be no less than 0.318 inch (8mm). Each cell shall weigh at least 14 kg with at least 8 ionizing wires.

Ionizer

Ionizing electrodes / wires shall be of tungsten material, rigidly supported both vertically and laterally. Ionizing electrode to ground electrode spacing shall be 1.0" (25mm). High voltage support insulators shall be of Teflon material, glazed to enhance dielectric strength and retard tracking.

Power Supply

Power supplies shall be 100% solid state, operate on 240 VAC, 50 HZ, 1 Phase input and provide a dual high voltage output of 12 to 13 KVDC for the ionizer and 6.0 to 6.5 KVDC for the collector in normal operation conditions. Current output at the high tension shall be 12mA. A maximum power output for the solid state power supply shall be 120 watts to maintain the specified collection efficiency. Integrally mounted Electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be overloaded self-protecting and accommodate an LED lights indicating the performance status of the ionizing/collecting cell.

High voltage output components in the power supply shall be sealed with epoxy for moisture resistance.

The power pack shall incorporate a short circuit arc protection with automatic power restoration system to prevent overload.

Performance Indicator Lights

There shall be 2 LED lights (Green & Red) installed on the access door of the unit to indicate the status of the air cleaning system. Control Panel should be as part of Main MCC panel meant for Kitchen ventilation system.

Blower Section

Blower section should be equipped with heavy duty energy efficient plug type fans along with constant driven fan motor. The fan motor should be direct mounted type with extended shaft. The motor should be out of Air stream by creating compartment in between Plug Type fan & motor. The compartment where motor is installed should be provided with louvers for Ventilation.

14.0 SHEET METAL WORK-

SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts.

GOVERNING STANDARDS

Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards – Metal and Flexible – Second Edition – 1995"-SMACNA)

RAW MATERIAL

Ducting

All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill Test Certificates.

Galvanizing shall be of 120gms/sq.m. (Total coating on both sides)

In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support systems shall be zinc-coated (galvanized). The bolts for fixing of slip-on flange corners should be of SS.

FABRICATION STANDARDS

All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory-fabricated or by equivalent technology. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply:

Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges to be machine treated using lockformers, flangers and roller for turning up edges.

Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance **with 2" (500 Pa) w.g. static norms as per SMACNA.**

All transverse connectors shall be the Rolamate 4 bolt slip – on flanges system or equivalent imported makes of similar 4-bolt systems with built-in sealant.

Non-toxic, AC-applications grade P.E. or PVC Gasketing is required between all mating Rolamate flanged joints. Gasket sizes should conform to flange manufacturer's specification. The sealant used at corner of the slip-on flanges & that sealant should withstand 100 ^{0}C & same should be non toxic.

DUCT CONSTRUCTION

The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

Dimensional Tolerances: All fabricated dimensions will be within +/- 1.0mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be +/- 1.0 mm per metre.

Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge

Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence

Plenums shall be shop/factory fabricated panel type and assembled at site.

The deflection of transverse joints should be within specified limit for rectangular duct deflection as per SMACNA Standards.

Reinforcement of ducts shall be achieved by either cross breaking or straight beading depending on length of ducts.

SUPPORT SYSTEM

A completely galvanized system consisting of fully threaded rods, slotted angles or double-L bottom brackets (made out of 3.0 mm M.S. sheet) nuts, washers and anchor bolts as supplied by supplier or generally conforming to SMACNA standards should be used. GI angle support system of adequate sizes shall also be provided at the bends, joints in vertical laying and wherever required as per site conditions or as directed by Engineer-in-charge.

Table 3 Support for Horizontal duct-Rectangular

Sr. No.	Maximum Duct Size(mm)	Hanger Rod Diameter	Interval (mm)
1	Up to-700	6mm	2400
2	701-1200	8mm	2400
3	1201-2000	10mm	2400
4	Above 2000	12mm	2400

As an alternative, slotted galvanized brackets attached to the top two bolts of the Rolamate system may also be used as appropriate for the site condition.

To provide the required thermal brake effect, Neoprene or equivalent material of suitable thickness shall be used between duct supports and duct profiles in all supply air ducts not enclosed by return air plenums.

INSTALLATION

Tools and tackles for site work

The duct installation shall conform to SMACNA norms. For duct assembly and installation the use of suitable tools and tackles should be used to give the required duct quality and speed of installation including (but not restricted to)

a) Electric Pittsburgh Seamer – used for closing Pittsburgh joints
b) Electric Slitting shear – to make cut-outs
c) Drilling machine with drill bits – for drilling holes in sheet metal work
d) Hammer drill machine with drill bits – for drilling holes in building structures for anchors
e) Hoisting system – for lifting the duct assembly upto mounting heights

Installation Practice

All ducts shall be installed as per tender drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.

All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building whether or not the same are shown on the drawings. Where there is interference/fouling with other beams, structural work, plumbing and conduits, the ducts shall be suitably modified as per actual site conditions.

Ducting over false ceilings shall be supported from the slab above, or from beams. In no case shall any duct be supported from false ceilings hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.

Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick appropriate insulation around the duct and totally covered with fire barrier mortar for complete sealing.

All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge.

DOCUMENTATION & MEASUREMENT FOR DUCTING

All ducts fabricated and installed should be accompanied and supported by following documentation:

1. For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of materials indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct area by gauge and duct size range as applicable.

2. Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

3. All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

TESTING

After duct installation, a part of duct section (approximately 5 % of total ductwork) may be selected at random and tested for leakage for class 12 as per SMACNA standards. The procedure for leak testing should be followed as per SMACNA- “HVAC Air Duct Leakage Test Manual” (First Edition)

All ductings must be fabricated at factory with SMACNA standard only, no site fabrication of ducts allowed except termination / connecting pieces.

FLEXIBLE DUCTWORK

The flexible ductwork shall have a liner and a cover of tough tear-resistant fabric equal in durability and flexibility to glass fibre fabric. The fabric shall be impregnated and coated with plastics. It shall be reinforced with a bonded galvanised spring of stainless steel or other approved wire helix between the liner and the cover An outer helix of glass fibre cord or equal shall he bonded lo the cover to ensure regular convolutions, flexible ductwork without a liner may not be used.

In no cases shall material containing asbestos fabric he used.

Alternatively, flexible ductwork shall consist of flexible corrugated metal tubing of stainless steel, aluminium, tin plated steel or aluminium coaled stud. The metal surface(s) may be coated with a plastics material.

The leakage from any section of flexible ductwork shall not exceed 1% of the local design air flow rate at the local maximum static pressure.

flexible ductwork shall be suitable for an operating temperature range of-5° C to 90° C and shall comply with BS 476 Rating Class P; Part 6 having an index of performance not exceeding 12 of which not more than 6 should derive from the initial period of test; Part 7 Class 1 (surface of very low flame spread) unless otherwise indicated.

ROUND DUCT CONSTRUCTION-

MAX SIDE (MM)	THICKNESS OF SHEET (GSS)	REINFORCING	JOINTS & SEAMS
Up to 200	24 G		Round duct sections are joined or by belling out one end of duct.
225 to 600	22 G		
625 to 900	20 G	32 mm x 32mm x 3 mm	girth angle reinforcing spaced on 8' centers.
925 to 1200	20 G	32 mm x 32mm x 3 mm	girth angle reinforcing spaced on 6' centers.
1225 to 1800	18 G	40 mm x 40 mm x 3 mm	-------do------
1825 to UP	16 G	40 mm x 40mm x 3 mm	girth angle reinforcing spaced on 4' centers.

C. HANGERS FOR DUCT-

DUCTSIZE (mm)	*SPACING* NOT EXCEEDING (m)	*SIZE OF MS ANGLE* (mm x mm)	*SIZE OF ROD DIA* (mm)
Up to 750	2.5	25 x 25 x 3	6
751 to 1500	2.5	40 x 40 x 3	6
1501 to 2250	2.5	50 x 50 x 3	10
Above 2250	2.5	50 x 50 x 3	12

14.1 VARIABLE AIR VOLUME BOX

Scope :

This specification covers the general design, materials, construction features, manufacturer, shop inspection and testing at manufacturer's works, delivery at site, installation, testing, commissioning and carrying out performance test at site of Variable Air Volume System with hot water coils for single and multi outlet as per the project requirement.

Codes and standards :

The design, material, construction features, manufacturer, inspection, testing and performance of air distribution system shall comply with all currently applicable statues, regulations, codes and standards in the locality where the system is to be installed. Nothing in this specification shall be constructed to relieve latest edition of following standards.

Construction Features :

Construction details shall be generally in accordance with the given here under.

VARIABLE AIR VOLUME (VAV) BOXES– COOLING with REHEATING APPLICATION

VAV boxes for varibale volume supply air systems with hot water coil of single or multiple outlet, flow rate range 21 to 4005 CFM suitable for connecting to pnumatic , electronic or DDC control circuits. Each VAV box is tested and the desired volume flow rates set in the factory.

The Sensing of the volume flow rates is by an averaging differencial pressure grid. The minimum and maximum volume flow rates set at the factory are capable of being site monitored and adjusted. Casing is lined with acoustic and thermal insulation, erosion resistant upto 20 m/s. Circular high pressure duct spigot connection, low pressure duct connection angle flange or side on flange. Casing air leakage rate complies to class A DW 142. The equipment conforms with clean room class 100 US standard 209b.

The boxes shall be as per ISO 5220 1981 standard of Airodynamic testing of VAV and CAV and ISO 3741 1988 of determination of sound power levels. The leakage rating shall be as per Class A of DW144 a988.

- At outlet hot water coil with factory fitted and tested without any control valves
- Casing from GSS , mineral wool lining and damper section to density of 30 to 40 Kg/m3 , with marglass facing suitable for velocities of up to 20 m/s ,(Fire rating BS 476 Pt6 , BS 476 Pt7 Class 1). Control damper from sheet steel with tip seal, aluminium sensor tubes , polyurethane plain bearings. Internal fiberglass lining shall have a protective marglass covering suitable for velocities up to 20 m/s. All plastic materials shall be UL listed fire retardant material
- The VAV box shall maintain sound pressure level of 35NC in general
- The actuator shall be of 24V AC , direct coupled to the damper shaft. Volume flow rate range approx 10:1 depending on the electronic velocity controller.Actual velocity signal can be measured dyanamically.Electrical supply 24 VAC, control signal 2 to 10 VDC/0 to 10

VDC. The required transformer to step down of the voltage range from 230V to 24V shall be part of the unit.

- The static differncial range is 20 to 1500Pa. The minimum allowable static pressure to the boxes for its satisfactory operation shall be 20Pa.

- Boxes shall be able to reset any air flow between proportions of 10:1. Air quantity limiters will not be accepted.

- The VAVs shall be used in standalone mode complete with own temperature sensor and controller and shall perform the function of maintaining the temperature and airflow. However, the controller on VAVs shall be BMS compatible open protocol to enable to network the VAVs to a network control unit and onto BMS. In this mode all VAV data shall be available at the BMS workstation and it shall be possible to change set points and flow setting from the BMS workstation.

- The height of the VAV shall be less than 400mm irrespective of the capacity.

- For multi outlet VAV boxes the distribution boxes based on given outlet numbers will be provided by VAV manufacturer. This will be installed after hot water coil.

Hot Water coil for Reheat

- The reheat will be done of primary air coming from AHU
- Hot water coil shall have flanged connection on both ends
- Hot water coil shall be of copper with aluminium fins plates
- The hot water coil shall be of 4 row based on actual reheating requirement
- The control valves shall be provided by HAVC contractor
- The reheating shall be done at VAV minimum air volume setting and shall be at constant air flow.
- In Multi outlet VAV shall have only one reheat coil

Mode of Measurement :

Representative from the contractor and engineer shall conduct a joint inspection of the Equipments. All the discrepancies observed either incomplete works of defective work shall be clearly indicated in the joint inspection report. The mode of measurement given below is for the purpose of measurement and payment and the scope of work shall be as specified else where in the specification.

14.2 GRILLES AND DIFFUSERS-

General

The grilles and diffusers shall be rated in accordance with ASHRAE standard 3672.

All grilles and differs shall have concealed fixing system and shall have quick release frame to facilitate cleaning.

All supply grilles and diffusers shall he mounted on substantial frame and shall be provided with soft rubber or felt joining ring inserted under the frame to prevent air leakage and the formation of condensate on the fitting,

All grilles and diffusers shall not be less than the size indicated; where no size is given they shall be capable of handling the air flows and distribution indicated without producing unacceptable air flow noise. The Contractor shall select the supply air grilles and diffusers to achieve good air distribution and adequate air movement in the conditioned space.

In order for the ceiling grilles and diffusers to match with the false ceiling layout pattern, the actual size of the grilles and diffusers shall he confirmed by the Architect/consultant before ordering.

For all grilles and diffusers which are smaller then the ceiling tile on which they are installed, they shall be located in the centre of the ceiling tile. The exact location of the ceiling grilles and diffusers shall be co-ordinate with other services. The Contractor shall confirm the exact location with the Architect/consultant before works commence.

Where grilles and diffusers are to be incorporated into false ceilings before any grilles or diffusers are installed into ductwork or fan coils, the Contractor shall ensure that the Building Contractor marks out the ceiling line on the adjacent plastered walls or columns and also indicates where ceiling tee bars line up or the ceiling joints occur in order that such datum can be worked to.

The finishing colour of the grilles and diffusers shall be approved *by* the Architect as different colours may be specified in different areas. The Contractor shall co-ordinate with the Building Contractor and other specialist Contractors especially the ceiling and electrical Contractor for the integration of the air diffuser into the ceiling and luminaire (for light troffer diffuser).

GRILLES

Grilles shall be of steel, aluminium, PVC or as otherwise indicated. Steel grilles shall he protected against rusting and supplied in fully finished stove-enamelled or otherwise specified condition.

Each supply air grille shall have two sets of separately adjustable louvres, one set horizontal and one set vertical, and shall be complete with an opposed blade multi-leaf damper. Alternatively in lieu of the opposed blade multi-leaf damper a rhombaidal air controller may be provided; this air controller shall control both the volume of air passing and the distribution of air across the grille lace. The louvers and the damper or air controller shall be adjustable from the front of the grille.

Return air grilles shall have either a single set of louvre or bars (either vertical or horizontal) or a lattice, egg crate or expanded metal from.

Each return air grille shall be complete with/without an opposed blade multi-leaf damper or a rhomboidal air controller operable from the front as specified.

Where return air grilles are fitted for fan coil units, they shall be arranged such that the central core of the grille hinged and demountable for access to the filter for cleaning.

Mounting frames for these grilles shall include provision for fixing the filter in position.

DIFFUSERS

Diffusers shall be of steel or aluminium. Steel diffusers shall be protected against rusting and shall be stove enameled/powder coated for finished colour approved by the Architect. Diffusers shall incorporate an edge seal, diffusers mounted on ceilings shall have anti-smudge rings. Pan type diffusers shall be provided except where cone type diffusers are indicated,

Diffusers shall be provided with volume control dampers of the iris, flap or sleeve type which shall be adjustable from the front of the diffuses Where the length of a vertical duct to a diffuser is less than twice the diameter of the diffuser an equalizing deflector shall be fitted.

The design of the supply air diffuser shall be capable to induce adequate air movement and provide the throw to cover the entire air-conditioning space without causing air turbulence and cold draft.

linear diffusers shall be constructed of extruded aluminium section and include a control damper al the rear of the vanes giving volume control down to complete shutoff and operated from the face of the diffuser. Linear diffusers for supply air shall have adjustable blades to give directional control of air flow. The linear diffuser shall be capable of maintaining a horizontal discharge pattern at a turn down ratio down to 20% of the maximum specified air volume without air dumping.

The linear diffuser shall be complete with factory fabricated plenum with suitable inlet connection for flexible ductwork, The plenum and diffuser neck shall be constructed of galvanised steel sheets internally lined with 25 mm 48 kg/m glass cloth faced fiberglass insulation enclosed in galvanised perforated metal liner.

Where linear diffusers are mounted in a continuous line there shall be means of ensuring alignment between consecutive diffusers and of equalizing pressure behind the vanes. The dummy portion of the diffuser shall be internally covered by a demountable galvanized metal enclosure to block the view into the ceiling void from below.

The square face diffuser for VAV system shall be constructed of aluminium and with large turn down ratio.

The linear slot diffuser shall be constructed of extruded anodized aluminium, with multiple slot for the required air flow rate,

All the supply air grilles/diffusers will be provided with opposed blade volume control dampers fabricated from Al. anodized in matt black shade. The damper should be suitable for operation from front face of grille/diffuser. The Diffusers should have also removable core type fixing facility, constructed from the same material of the diffuser. The grilles / diffusers must be submitted to Architect / HVAC consultant / PMC / Client for prior approval before procurement and installation.

INSTALLATION-

A good quality expanded polyethylene /rubber of uniform thickness and width shall be used as gasket between flange joints. The gaskets shall be fixed by a suitable adhesive and holes made by passing a heated rod through.

All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angles of ample size to keep the ducts true to shape and to prevent

buckling, vibration or breathing. All the joints shall be made tight and all interior surfaces shall be smooth. Bends shall be made with radius not less than one half the width of the duct or with properly designed interior curved vanes where metal ducts or sleeves terminate in woodwork, brick or masonry openings, tight-flanged collars. Ducting over false ceiling shall be supported from the slab above or from beams.

In no case a duct shall be supported from the false ceiling hangers or to be permitted to rest on a hung ceiling.

All holes in concrete, masonry etc. made by contractor for fixing supports etc. shall be made good and restored to original finish by him.

Air handling units and fans shall be connected to duct work by inserting at air inlet and air outlet a double canvass sleeve. Each sleeve shall be minimum 100mm long, securely bolted to duct and units. Each sleeve shall be made smooth and the connecting ductwork rigidly held in the line with unit inlet or outlet.

TESTING-

All the test readings shall be furnished for peak summer and monsoon outside conditions.

After completion all such system shall be tested for leakage.

The entire air distribution system shall be balanced to supply the air quantities as required in various zones and rooms to maintain the specified room conditions. The final readings shall be recorded and submitted to the Consultant for approval before acceptance and taking over of the entire system by the Employer.

PAINTING-

Angle iron flanges, stiffeners, hangers and supports shall be painted with 2 coats of anti rust primer and those remaining uncovered shall be further painted with 2 coats of synthetic enamel paints of black colour.

DOUBLE DEFLECTION ADJUSTABLE BLADE GRILLE:

To be constructed from high quality aluminium alloy extrusions with cleated & mitred frames Vanes should be in double banks are individually adjustable shape of vanes should be teardrop and are held in position with stainless steel spring wire for long life.

Finish of grille should be epoxy polyester powder coated & shade should be as per Architect / interior designers choice.

LINEAR GRILLES

To be constructed from extruded aluminium sections fabricated in to modular assemblies frames are mitred & cleated.

Finish of grille should be epoxy polyester powder coated & shade should be as per Architect / interior designers choice.

AIR TRANSFER GRILLES

Should be suitable for mounting in doors, partitions and wall should have no sight feature to be constructed from aluminium extrusions sections fabricated in tube cores and mitred, cleated frames.

Finish of grille should be epoxy polyester powder coated & shade should be as per Architect / interior designers choice.

SLOT DIFFUSER

Liner slot diffusers shall be fabricated from high grade aluminium alloy extrusions fixed or clipped stays allowing easy removal of internal flow control vanes and pattern control elements should have fully adjustable air pattern from horizontal to vertical.

Finish of diffusers should be epoxy polyester powder coated & shade should be as per Architect / interior designers choice.

14.3 DAMPERS – GENERAL

The respective functions, types and general constructional requirements of dampers shall be in accordance with the HVAC ductwork specification unless otherwise indicated, sufficient dampers shall he provided to regulate and balance the system. Dampers on grilles or diffusers shall he used for line control only.

All dampers shall he of flanged type for connection to ductwork and shall he sufficiently rigid to prevent fluttering. Air leakage rate for dampers shall be tested according to EN 1751 Section 3 when the damper is in the closed position. For dampers installed for shut- off purpose, the maximum air leakage rate shall be tested according to EM 1751 Section 4.

LOW LEAKAGE DUCT DAMPER

Air volume control dampers shall be of the aerofoil, double skin, opposed blade type with low pressure drop and noise regeneration characteristics. Damper blades in rectangular ductwork shall not exceed 225 mm in width and 1500 mm in length. Blades shall be of hollow section constructed from the same material of the ductwork or of stainless steel encapsulating an internal double contoured stud longitudinal reinforcing bar, mounted on square section steel spindles. Bearings shall be of nylon material and the units shall be of low-leakage design by incorporation of synthetic trailing edge seals and a peripheral gasket which shall be tested according to BS 476. All manually and automatically operated dampers shall include a means for indicating externally the position of the blades. Manual dampers shall include a device for positioning and locking the damper blades. The positions of all dampers 'as-set' after final regulation shall be indelibly marked at the adjusting device.

Each air volume control damper in the ductwork shall be fitted with a non-corrodible label stating the actual air flow in m^3/s when in the fully open position, its overall cross sectional area, and the degree to which the damper has been closed in order to achieve the design or actual air flow.

Unless otherwise indicated, quadrants and operating handles shall be of die-east aluminum or other material approved by the Architect with the words 'OPEN' and 'SHUT' marked on the

quadrant. Quadrants shall be securely fixed and the damper spindles shall be closely fitted in the quadrant hubs to prevent any damper movement when the damper levers are locked.

Access openings with readily removable air sealed covers shall be provided adjacent to all dampers. Subject to limitations of ductwork size the dimensions of access openings shall not be less than 300 mm x 300 mm and shall be located so as to afford easy access for inspection and maintenance.

BUTTERFLY & BIFURCATING DAMPERS

Butterfly dampers shall each consist of two plates, edge seamed, of at least the same thickness as the material from which the associated ductwork is made, and rigidly fixed to each side of a mild steel operating spindle, the ends of which shall be turned and housed In non-ferrous bearings.

Bifurcating dampers shall be of 2 mm thick sheet for sizes up to 450 mm square, for larger sizes the thickness shall be as specified. The damper blades shall be rigidly fixed to square section mild steel spindles, the ends of which shall be turned and housed in non-ferrous bearings,

Each leaf of a multi leaf damper shall consist of two plates of material of the same thickness as the associated ductwork and rigidly fixed to each side of an operation spindle, the ends of which shall he housed in brass, nylon, oil impregnated sintered metal, PTEE impregnated or ball bearings. The ends of the spindles shall be linked so that one movement of the operating handle shall move each leaf for an equal amount. The mechanism shall be located outside the air stream.

For system static pressure below 1000 Pa or ductwork velocity below 12 m/s, blade of at least 50 mm wide shall be used. For static pressure at or above 1000 Pa_h at least 100 mm wide blade shall be used. Central blade reinforcement bar shall be provided for damper span longer than 1500 mm. Single module of a damper shall not exceed 2000 mm width and 1000 mm height.

TERMINAL DAMPERS

Grilles and air diffusers with rectangular neck connections shall be provided with an opposed blade dumper, screwed or riveted lo the neck connection and designed specially lo facilitate final balancing of the system.

Damper frames, blades and operating mechanism shall be constructed from an aluminium alloy or, alternatively, formed mild steel suitably finished to give protection to the material during the design working life,

Blades shall be made of solid section material and shall be firmly held in position by a spring steel retaining mechanism. The blade setting mechanism shall be accessible through (he grille or diffuser blades and shall be suitable for operation with an "Alien" key. Where dampers are visible through the grille or diffuser they shall *be* finished with a mall black paint.

15.0 MOTORISED FIRE & SMOKE DAMPERS

GENERAL

WORK INCLUDED

Combination fire smoke dampers with steel 3-V blades meeting requirements of UL Standard 555 7th Edition and UL Standard 555S 4th Edition.

RELATED WORK

A. Section 15810 – Ducts.
B. Section 15900 – HVAC Instrumentation and Controls: Connections to actuators.

REFERENCES

A. AMCA 500-D – Laboratory Methods for Testing Dampers for Ratings.
B. AMCA 511 – Certified Ratings Program for Air Control Devices.
C. CSFM – California State Fire Marshall Listing for Fire Damper and Smoke Damper (leakage).
D. New York City MEA – New York City, Department of Buildings, Material and Equipment Acceptance Division.
E. IBC – International Building Code
F. NFPA 80 - Fire Doors & Other Opening Protectives
G. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
H. NFPA 92A – Smoke Control Systems
I. NFPA 92B – Smoke Control Systems in Atria, Covered Malls, and Large Areas.
J. NFPA 101 – Life Safety Code.
K. UL 555 (Seventh Edition)– Standard for Safety: Fire Dampers
L. UL 555S (Fourth Edition) – Standard for safety: Leakage Rated Dampers for Use in Smoke Control Systems.

SUBMITTALS

A. Comply with requirements of Section 01330 – Submittal Procedures.
B. Product Data: Submit manufacturer's product data.
   1. Include UL ratings for fire resistance, leakage, ww

QUALITY ASSURANCE

A. Dampers shall meet requirements for combination fire smoke dampers in accordance with:
   1. NFPA 80, 90A, 92A, 92B, and 101.
   2. CSFM Fire Damper Listing.
   3. CSFM Leakage (Smoke) Damper Listing.
   4. New York City MEA Listing 260-91-M Vol. III.
   5. Applicable Building Codes.

B. Dampers shall be tested, rated, and labeled in accordance with:
   1. UL 555 (Seventh Edition), Listing R13317
   2. UL 555S (Fourth Edition), Listing R13317

C. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.

DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver Materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions.

C. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

PRODUCTS

COMBINATION FIRE SMOKE DAMPERS

Ratings:

1. Fire Resistance:
   - **Dampers shall have a UL 555 fire resistance rating of 1½ hours.**
2. Fire Closure Temperature:
   Each combination fire smoke damper shall be equipped with a factory installed heat responsive device rated to close the damper when the temperature at the damper reaches:
   - 165°F
3. Elevated Operational Temperature:
   - **Dampers shall have a UL 555S elevated temperature rating of 350°F.**
4. Leakage:
   - **Dampers shall have a UL555S leakage rating of Leakage Class I**
5. Differential Pressure:
   - Dampers shall have a minimum UL 555S differential pressure rating of 4 in. wg.
6. Velocity:
   - Dampers shall have a minimum UL 555S velocity rating of 2000 fpm.

Construction:

1. Frame:

Damper frame shall be 16 ga. galvanized steel formed into a 5" x 1" structural hat channel. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

2. Blades:

Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1" deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.

3. Blade Stops:

Each blade stop (at top and bottom of damper frame) shall occupy no more than ½" of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

4. Seals:

a. Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
b. Jamb: Flexible stainless steel compression type.

5. **Linkage:** Concealed in jamb.

6. **Axles:** Minimum ½ inch dia. plated steel. Frame: Galvanized steel (in gauges required by manufacturer's UL listing).

7. **Sleeves:** Damper shall be supplied as a single assembly with an integral factory sleeve.

8. **Bearings:** Axle bearings shall be sintered bronze sleeve type rotating in polished extruded holes in the damper frame.

Actuators:

1. Type:
   - Electric, 230V AC, 2-position

2. Mounting:
   - External

SOURCE QUALITY CONTROL

A. Factory Tests: Factory cycle damper and actuator assemblies to assure proper operation.

EXECUTION

EXAMINATION

Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

INSTALLATION

A. Install dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.

B. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to

provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

C. Install dampers square and free from racking.

D. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

E. Do not compress or stretch the damper frame into the duct or opening.

F. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

G. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

H. Install connections to [electric, pneumatic] actuators as specified in section 15900.

I. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

15.0 (B) FIRE DAMPERS (MOTORIZED) (Non UL Listed) - If Applicable

3.1 Fire Dampers shall be motorized of atleast 2 hours Fire Rating certified by CBRI, Roorkee as per UL 555:1973.

3.2 Fire Damper blades & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be pivoted on both ends using chrome plated spindles of self lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 G galvanized sheet steel. For preventing smoke leakage side seals will be provided.

3.3 In normal position damper blade shall be held in open position with the help of a 220V operated motorized actuators thereby providing maximum air passage without creating any noise or chatter.

3.4 The damper shall be actuated through electric motorized actuator. The actuator shall be enerzised with the help of a signal from smoke detector. Smoke detector shall be provided by Fire Fighting agencies. The Fire Damper shall be provided with micro switches with bakelite base to stop fan motor in the event of damper closure. The reopening of damper shall be manual.

3.5 Fire Dampers shall be mounted in Fire Rated Wall with flange connection.

3.6 Dampers shall be installed in accordance with the installation method recommended by the manufacturer.

16.0 FIRE DAMPER WITH FUSIBLE LINK AND SPRING TYPE MECHANISM

Fire dampers shall be CBRI type tested and certified for 90 minutes rating against collapse and frame penetration as per UL 555-1995 as per details given at XI C.

Fire Dampers meeting the following specifications shall be supplied and installed. Dampers shall meet the requirements of the latest edition of NFPA 90A, 92A, and 92B.

Dampers shall have a UL555S Leakage rating of Class I and a Temperature rating of 177 C. Dampers shall have a UL555S operational airflow rating equal to or greater than the airflow at its installed location and an operational pressure rating of 101.6 mm H2O.

Damper blades shall be 1.6 mm galvanized steel with Aerofoil design blade of thickness (1+1)mm. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper (blades that are non-symmetrical relative to their axle pivot point or utilize blade stops larger than 13 mm are unacceptable).

Damper frames shall be galvanized steel formed into a structural hat channel shape with reinforced corners. All component of stainless steel should be used in fire dampers Bearings shall be stainless steel type rotating in extruded holes in the damper frame. Jamb seals shall be stainless steel compression type.

17.0 VOLUME FLOW LIMITER

Scope

A. This section covers the construction and installation of constant air volume boxes associated with the air conditioning systems indicated on the drawings.

General

A. The design, construction, material and finishes of all the units shall be suitable for the locations, climatic and operating conditions indicated in this specification and drawings.

B. These shall of the Pressure Independent constant air volume boxes and shall be a proprietary line as marketed by a firm specializing in the field, with at least five years experience in supplying VFL boxes.

C. The main objective of the VFL shall be to balance flow volume in ventilation and air conditioning systems.

Construction

A. VFL should be made of high quality plastic material (UL 94 V1).

B. It should be mechanically powered, which shall include a control damper, regulator spring and low friction, silicon free damper element.

C. There should be a provision of changing the flow setting at of the VFL, on site, incase required.

D. Regulator spring should be made of stainless steel.

E. The regulation of the volume flow should be $\pm$ 10 % , relative to maximum flow rate , in the pressure range from 30 to 300 Pa.

F. It should be tested for air handling and set to a reference volume flow in the factory.

G. A lip seal should be there to ensure a snug fit between the VFL and the round duct.

H. It should have the provision to be installed in any orientation.

Installation

A. Install air terminals units in positions shown in the drawings.

B. Align and level all units.

C. Fix all units in the round ducts, by sliding it in the ducts on locations as shown on drawings.

D. Ensure adequate space is available around the units to allow inspection and maintenance of all components in accordance with the manufacturers recommendation.

E. Stickers should be affixed to the outside of the air duct in an easily visible position, so that the location of the VFL's can be found, if required in future.

F. Co-ordination of air terminal location shall be made with the ceiling pattern, to ensure easy access in the future.

G. Manufacturer's recommendations on installation shall be followed.

Commissioning

Carry out static check on units, settings of volume flow, to ensure conditions are safe prior to start up.
Operate units to ensure all control components function correctly.

EXHAUST VALVES FOR TOILET EXHAUST – IF APPLICABLE

Are to be constructed from steel spinnings & to be protected by white powder coated finish.

Volume control dampers (Duct mounted) Frames and blades are to be constructed from high quality extruded aluminium section Blades are pivoted on PVC bushes and operate through PVC gear system which should be enclosed within the damper frame volume control dampers should have following features.

Stainless steel side seal gaskets opposed blade operation.

Aerofoil blade sections.

Fully enclosed blade linkage mechanism PVC gear operation.

Manually operated knob lockable / removable type Blade position indicator.

18.0 SOUND ATTENUATORS

The sound attenuators have been design to avoid noise interference between inter connected areas.

The casing shall be manufactured from galvanized sheet metal 1.00mm thick to BS 2989 grade with spot welded seams or lock for formed seams, with a mastic sealant the construction complies with DW 142 Class – B code. Attenuating splitters are constructed from a press formed frame of G.I sheet and incorporate high density & highly absorbent fiber glass insulation material with fiber glass tissue covering with 26 SWG perforated aluminium sheet.
The Acoustic lining complies with class – O building regulations & has a class tissue facing for erosion protection. The splitters have faired entry and exit noses to minimize pressure drop. The Splitters are radiussed at both ends to minimize air Pressure loss and regenerated noise.

RECOMMENDED DESIGN CRITERIA

Situation	NC
Concert halls, Sound Recording Studio, Live Theaters	20
Bed Room TV Studio, Conference / Lectures Rooms	25
Leaving Rooms, Board Room, Multi Purpose Halls Libraries, Hotels Bed Room, Banquet Hall, Operation Theater, Cinemas, Court Rooms & Private Room of Hospital etc..	30
Public Rooms in Hotels, Ball Rooms, General Word in Hospital, Small Offices, School Class Room, Museums, Banking Hall, Small Restaurant, Cock tail Bars & Quality Shops	35
Toilets & Wash Rooms, Open Offices, Reception areas, Halls, Corridors, Lobbies in Hotels & Hospital, Post Offices, Recreation Rooms, Large Restaurants, Bars & night Clubs, Departmental stores, shops, Gymnasia etc…	40
Kitchens in Hotels, Hospitals etc.., Laundry Rooms, Computer Rooms, Cafeteria, canteens, Super Markets, Swimming Pools, Offices, etc…	45

19.0 ULTRA VIOLET GERMICIDAL IRRADIATION SYSTEM

The UVGI System should be designed to achieve at least 90 % kill rate per pass of all air borne bacteria and virus. The intensity of UV energy delivered should be based on the project specified Kill Rate of the specified bacteria or the bacteria that causes the defined disease. If such value is not specified, the energy delivered should be based on default value not less than 3,000 µwsec/cm².

The Manufacturer should provide scientifically developed Selection Charts to prove the delivery of designed intensity of Kill Rate. An individual Selection Chart should be provided for each unit. Selection should be based on parameters such as air velocity across the UVGI unit, length of design contact duct downstream, and upstream of the UVGI System, and the target intensity of energy to be achieved. The Selection Charts should incorporate all of the above parameters.

The contact duct length for design Kill Rate upstream and downstream of the UVGI Should be clearly defined by the manufacturer. The length of straight duct should be provided by the HVAC contractor at site. These contact duct lengths should correspond to the lengths used in the Selection Chart. As this is essential in establishing the Kill Rate and the system dependability, this clause cannot be waived.

The energy level of the lamp used in above selection should be based on the energy level at the end of design lamp life and not at the beginning.

The Lamp should be fabricated out of Quartz Glass. The Lamp should be inserted in a Coaxial Quartz Glass outer tube, end to end. This is to ensure deposits of water, condensation, dust and particulate settlement do not cause lamp failure or safety concerns.

Only environmentally friendly Amalgam filled Lamp should be used. This ensures reduction of Mercury contamination to promote environmentally friendly system.
Only Pre Heated Lamps should be used. This is to ensure the lamp life does not decrease significantly due to number of starts. Instant Start Lamps are not acceptable.

Lamp life should be typically not less than 14,000 hours of continuous operation. Shorter lamp life should not be acceptable.

The entire UVGI System should be self contained unit, with all components factory assembled in one neat compact SS 18 G thick Frame, suitable for duct mounting. The system should be provided with companion flanges with UV rated gasket.

UV emitting lamps should be placed to ensure entire cross-sectional area of the duct is enveloped with UV rays of the specified wavelength with no possibility of bypass by pathogens.

The design intensity of the lamp should be based on wavelength 254 nm. It should be ensured the lamp should not perform at ultra low wavelength 180 nM or lower, to ensure no uncontrolled and unmodulated ozone is put out by the lamp.

The system should be suitable for operation in air medium temperature 50°F (10°C) to 140°F (60°C), RH 0 to 100 %.

The UVGI should be electrically interlocked to AHU fan motor contactor.

UV Intensity Sensor should be factory installed. UV Intensity Monitor should be installed on the outer case. Control wiring between the two should be factory installed. The Monitor should indicate the intensity of UV rays in µw/cm². The Monitor should also deliver 0 – 10 VDC Analog Signal for interface to BMS. The Monitor should also provide at least 1 NO Dry Contact which may be set to activate at user selectable UV intensity level.

The system should be provided with Hour Meter. This facilitates timely lamp change-out at end of lamp life.

Terminal Block should be provided on the outer case of the UVGI System to ensure field wiring is minimized, foolproof, and with reduced labor time. The outer case should be provided with Ballasts, ON/OFF Switch with indicating lamp to show System On, Fuse, Hour Meter to indicate hours of operation of lamps.

The System should be with factory provided electrical interlock to shut off the lamp in the event the door is opened.

The operating voltage should be 220 V, 1 Phase, 50 Hz (110 V, 1 Phase, 60 Hz). The equipment should be properly grounded.

The System should be UL Listed. To ensure safety, unlisted equipment is not acceptable.

19A. BOX TYPE TERMINAL HEPA FILTERS

High efficiency particulate air (HEPA) filters having minimum filtration efficiency of 99.997% to 0.3 microns, complete with 16G power-coated filter box insulated with 20mm back and supported from building structure; SS perforated plate, DOP test port, damper, etc. Filter access & replacement shall be from the rooms and gear operated damper to be provided.

20.0 NOISE AND VIBRATION CONTROL

GENERAL

This section of the Specification intends to direct the Contractor to select the appropriate and sufficient noise and vibration control measures on the plant/equipment, the interconnected piping, ductwork and conduit so that when the installed plant/equipment are put into operation, the resulting noise and vibration levels at locations within the building and at the adjacent or nearby buildings shall not exceed the acceptable limits.

The Corrected Noise Level at potential Noise Sensitive Receiver in the adjacent or nearby building, if so identified in the Particular Specification and/or Drawings, shall not exceed the Acceptable Noise Level stipulated in the Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites issued by the Environmental Protection Department when the plant/equipment installed by the Contractor are put into operation.

EQUIPMENT BASES

GENERAL

Floor mounted equipment shall be installed on 100 mm high concrete housekeeping pads provided by the Building Contractor covering the whole floor area requirements of the equipment bases plus a minimum of 150 mm further on each side or on inverted beams at the roof. Vibration isolators shall be mounted on this concrete pad or inverted beams.

WELDED STRUCTURAL STEEL BASES

Bases shall be constructed of adequate T or channel steel members reinforced as required to prevent the bases from flexing at start-up and from misalignment of drive and driven units.
All perimeter members shall be of steel sections with a minimum depth equal to 1/10th of the longest dimension of the base but need not exceed 350 mm provided that the deflection and misalignment are kept within acceptable limits as determined by the equipment manufacturer.
Height saving brackets shall be employed in all mounting locations to provide a base clearance of 50 mm.

CONCRETE INERTIA BASES

Concrete inertia bases shall be formed within a structural steel beam or channel frame reinforced as required to prevent flexing, misalignment of the drive and driven units or transferal of stresses into equipment. The base shall be completed with height saving brackets, concrete reinforcement and equipment bolting down provisions.

In general the thickness of concrete inertia bases shall be of a minimum of 1/12th of the longest dimension of the base but never be less than 150 mm. The base depth needs not exceed 300 mm unless specifically required.

As an indication of the standards required, minimum thickness of the inertia base shall generally comply with the following table or be 1/12th of the longest dimension of the base, whichever is the larger: -

Minimum Thickness of Inertia Base

Motor Size (KW)	Minimum Thickness
3.7- 11	150mm
15- 37	200mm
45- 55	250mm
75 - 185	300mm

Base forms shall include minimum concrete reinforcement consisting of 13 mm bars or angles welded in place on 150 mm centers running both ways in a layer of 40 mm above the bottom, or additional steel as is required by the structural conditions.

Unless otherwise specified, concrete inertia bases shall weigh from 2 to 3 times the combined weight of the equipment/plant to be installed thereon.

Base forms shall be furnished with drilled steel members and with anchor-bolt sleeves welded below the holes where the anchor bolts fall in concrete locations.

Height saving brackets shall be provided in all mounting locations to maintain a base clearance of 50 mm.

VIBRATION ISOLATORS

The following types of vibration isolation mountings or suspensions are not exhaustive but serve to cover the main types that shall be applied as appropriate unless otherwise stated in the Particular Specifications.

FREE STANDING SPRING MOUNTS

These shall be free standing and laterally stable without any housing and complete with a minimum of 6.0 mm neoprene acoustical friction pads between the base plate and the support.

All mountings shall have leveling bolts that must be rigidly bolted to the equipment.

Spring diameters shall be no less than 80% of the compressed height of the spring at rated load with horizontal spring stiffness 1.1 times the rated vertical spring stiffness.
Springs shall have a minimum additional travel to 'solid' (fully compressed) equal to 50% of the rated deflection.

Springs shall be so designed that the ends of the springs remain parallel.

The springs selected for any given application shall be non-resonant with the equipment's or support structure's natural frequencies. This shall apply to all springs hereafter described.

RESTRAINED SPRING MOUNTS

Equipment with operating weight different from the installed weight such as chillers, boilers etc. and equipment exposed to the wind such as cooling towers and other roof mounted plants shall be mounted on spring mountings but a housing shall be used that includes vertical limit stops to prevent spring extension when some of the weight is removed, i.e. when the system is drained or lifted by abnormal wind pressure.

DOUBLE DEFLECTION NEOPRENE MOUNTS

These mountings shall have a minimum static deflection of 8.5 mm. All metal surfaces shall be neoprene covered to avoid corrosion and shall have friction pads on both the top and the bottom so that they need not be bolted to the floor. Bolt holes shall be provided for applications where bolting down is required.

NEOPRENE PADS

These mountings shall consist of 'waffle' form neoprene pads of 8.0 mm thickness. Where required these shall be adhesive cemented to 3 mm steel plate of similar area so as to form a sandwich.

The area of pad to be used and the number of layers shall be determined for each application in accordance with the manufacturer's recommendations.

21.0 THERMAL & ACOUSTIC INSULATION

SCOPE

The scope of this section comprises the supply and application of insulation conforming to these specifications.

DUCT INSULATION – MODE MEASUREMENT DUCT SURFACE AREA

MATERIAL

- Insulation material shall be Closed Cell Elastomeric Rubber
- Density of Material shall be between 40 to 60 Kg/m3
- Thermal conductivity of elastomeric Closed Cell Elastomeric Rubber shall not exceed 0.033 W/m.K at mean temperature of 0°C
- Insulation material shall have anti-microbial product, which is EPA (Environmental Protection Agency), USA approved, as an integral part of insulation that can not be washed off or worn off.
- It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and should confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180.
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990
- Material should be FM (Factory Mutual), USA approved.
- Water vapour permeability shall not exceed 1.74 x 10^{-14} Kg / (m.s.Pa), i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 10000.

Thickness of the insulation shall be as specified for the individual application.

THICKNESS SELECTION CHART FOR CLOSED CELL ELASTOMERIC RUBBER INSULATION **Design Basis: Condensation Control**				
DUCT INSULATION				
	Required Thickness (mm)			
Supply Air Duct (Line Temperature 14 Deg. C)	18			
Return Air Duct (Line Temperature 22 Deg. C)	8			
Supply Air Duct in Return Air Path (Line Temp. 14 Deg.C)	8			

External thermal insulation installation procedure:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.
- Material shall be fitted under compression and no stretching of material should be allowed.

- A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface.
- When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.
- All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
- The adhesive shall be strictly as recommended by the manufacturer.
- The detailed Application specifications are as per the manufacturer's recommendation.

ACOUSTIC INSULATION

- Material shall be engineered Open Cell Elastomeric Rubber foam
- The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO 354, should be minimum as per enclosed chart
-

Freq (Hz)	**125**	**250**	**500**	**1000**	**2000**	**4000**	**NRC**
10 mm	0.03	0.04	0.14	0.04	0.88	1.00	0.35

- The material should be fibre free
- The density of the same shall be within 140-180 Kg/m^3
- It should have antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180.
- The material should have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C
- The material should withstand maximum surface temperature of $+85^0C$ and minimum surface temperature of -20^0C
- The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996.
- The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

DUCT ACOUSTIC LINING

Ducts so identified and marked on Drawings and included in Schedule of Quantities shall be provided with acoustic lining.

INSTALLATION PROCEDURE

The inside surface for the ducts shall be covered with adhesive. Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surface

22.0 PIPING INSULATION

MATERIAL

- Insulation material shall be Closed Cell Elastomeric Rubber
- Density of Material shall be between 40 to 60 Kg/m3
- Thermal conductivity of elastomeric Closed Cell Elastomeric Rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990
- Material should be FM (Factory Mutual), USA approved.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 7000.

Thickness of the insulation shall be as specified for the individual application

All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. **An air gap of 100 mm shall be present between adjacent insulated surfaces carrying chilled water or refrigerant and also between the insulated surface and the wall to allow natural ventilation without affecting its external surface coefficient of heat transfer.** Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Closed Cell Elastomeric Rubber insulation shall be applied as follows:

- Insulating material in tube form shall be sleeved on the pipes.
- On existing piping, slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer.
- Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.
- Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
- The insulation shall be continuous over the entire run of piping, fittings and valves.
- All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

The detailed application specifications are as mentioned separately. The manufacturer's trained installer should only be used for installation.

THICKNESS SELECTION CHART FOR CLOSED CELL ELASTOMERIC RUBBER INSULATION **Design Basis: Condensation Control**				
CHILLED WATER PIPING **LINE TEMP 7 DegC**				
Pipe NB (mm)	**Required Thickness (mm)**			
Up to 32	19			
Up to 600	25			
Chilled Water Tank	25			
DRAIN PIPING **LINE TEMPERATURE 15 DegC**				
Pipe NB (mm)	**Required Thickness (mm)**			
Up to 50	13			

PROTECTIVE COATING OVER INSULATION

Specification Clause:

For protection against mechanical impact , Scratch and UV – treated woven glass fibre covering - should be applied on all insulated pipes.

Technical Details:

Temperature Range: - 50°C to +150°C Overall

Colour: Black

Density: 205 + 10 gms / sq. meter

Application Notes:

The covering should be cut to size according the circumference of the insulated pipe – please allow an additional 50mm for the overlap of the covering material. The Overlap shall be securely fixed using recommended Adhesive.

Spread thin film of recommended on the 50mm overlap and close the seam. When covering fittings, please consult the manufacturer's Application Manual. All fittings have to be covered to the same standards as the covering of the pipe work. No additional vapor barrier is needed.

When applying in pipe/duct, mastic should be applied on the overlapping joint.

DATA CENTRE FLOOR INSULATION

Floor of data centre shall be insulated with extruded polystyrene insulation as described below:

Clean the floor

Coat the floor with Dupont tyvek Solid

Stick 50 mm thick, extruded polystyrene insulation of 30 kg / mtr density 250 kpa compressive strength

PUMP INSULATION

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

SHELL INSULATION

The chiller shells shall be factory insulated in accordance with the manufacturer's standards.

COLD WATER AND EXPANSION TANK INSULATION

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer's standard.

UNDERDECK INSULATION

Underdeck insulation shall be 25mm thick EPDM insulation sheet. Underdeck surface of ceiling shall be cleaned and made dirt free. Insulation sheet shall be pasted on this surface with modified neoprene contact adhesive. 28g wire net shall be tightened around insulation so as to avoid any kind of sagging. Ends of net shall be overlapping by at least 25mm. Overlaps shall be screwed with galvanised screws to avoid rusting.

MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith

a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.

AHU ROOM WALL INSULATION

Material

The material for acoustic treatment of ducts, rooms, roofs etc. shall be resin bonded fibre glass, as described earlier, conforming to IS: 8183 of 1976.

The density of fibre glass shall be 48 kg/cub.m and the material shall be in the form of boards of uniform density.

The 'k' value at 10°C shall not be less than 0.03 W/mK. Facing shall be provided with 0.8 mm thick perforated aluminium sheet held with G.I. Nuts bolts or nailed to the batten work as required.

The thickness of insulation shall be 50 MM unless otherwise specified elsewhere:

APPLICATION FOR AHU ROOM ACOUSTIC INSULATION

Clean wall / ceiling surface which is to be acoustically lined.

Fix 22 Gauge GI framework of 50mm x 50mm size spaced at 600mm x 600mm c/c (horizontal) to the wall with screw/bolts.

Insulating material of specified thickness shall be fixed in GI frame of 600mm x 600mm dimension, and wrapped with RP tissue

Cover with 26 gauge perforated AI sheet with 20-25% perforations placed free area using self tapping screws onto the frame work

Plain aluminium beading 25mm wide is then placed at the joints of the perforated sheeting and secured to the framework using self-tapping screws.

Acoustic lining of walls shall be terminated 150mm above the finished floor to prevent damage to insulation due to accidental water logging in AHU room.

23.0 CHEMICAL DOSING SYSTEM

SYSTEM DETAILS & MAKE-UP WATER QUALITY

To enable the water treatment vendor to design the treatment program, the hvac contractor shall provide all the system details for the condenser water as well as for the chilled water system. The program shall be suitable for the make-up water quality available at site. In the event of make-up water quality details are not available at the time of tendering then the water treatment vendor will suggest the make-up water quality parameters suitable for the treatment program so that the client can make provision for such a quality make-up water or alternatively in the event of non availability of such make-up water, the water treatment vendor can modify the treatment program in future with respect to the make-up water quality available at site.

FOR CONDENSER WATER SYSTEM

Supply, install and commission an automatic chemical dosing cum control unit of which the controller will have the facility for automatic blow down and timer based facility for biocides dosing –minimum 01 oxidising biocide & 02 no. Non oxidising biocides (anti algae & bacteria etc) . The chemical dosing pumps shall be –electronic-diaphragm type dosing pump (05 no). Which will be required 01 no. Pump for dosing chemical for corrosion (rusting) and scale control and 03 no. For algae /bacteria control & 01 no. As standby for ph-control as and when desired.

BACK –UP SUPPORT AND SERVICES

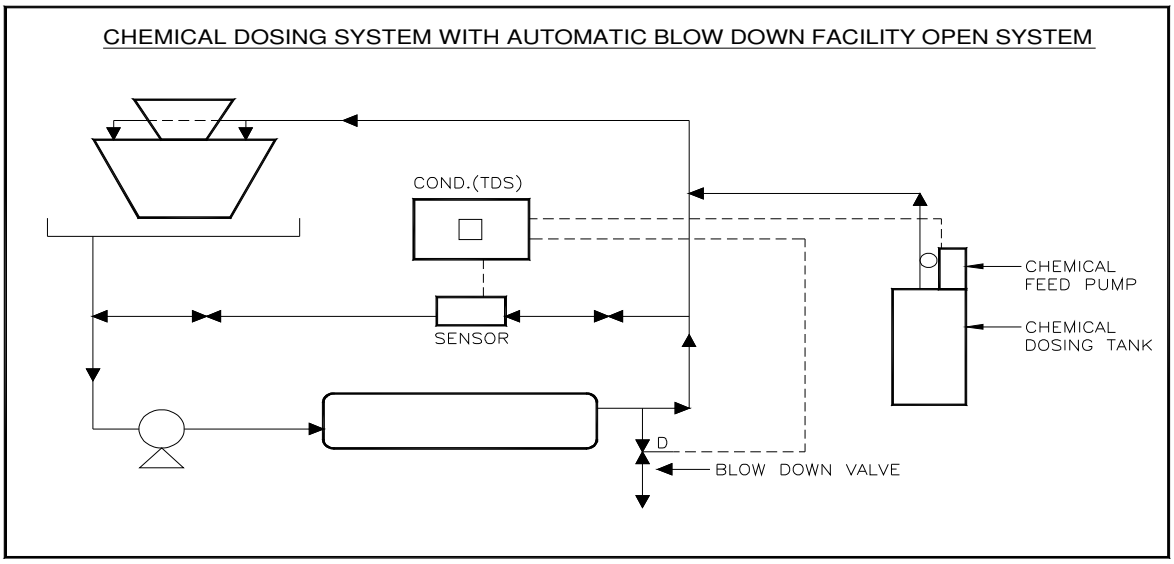
The Water Treatment Vendor Will Provide Back-Up Support And Advisory Services To The HVAC Contractor During The Installation, Initial Start-Up And During O & M Period

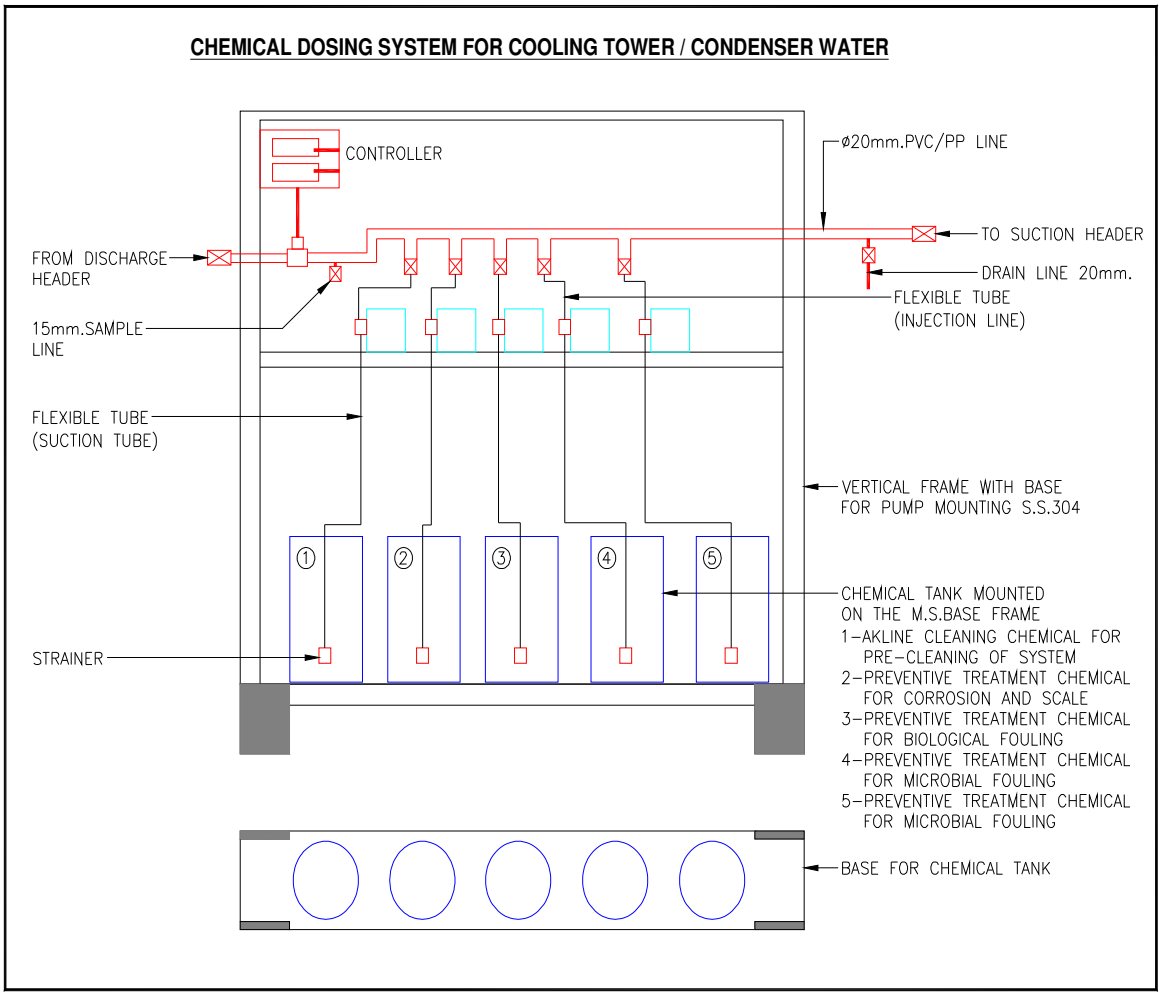
CONDENSER WATER CHEMICAL DOSING SYSTEM

CHEMICAL DOSING SYSTEM WITH AUTOMATIC BLOWDOWN FACILITY OPEN SYSTEM

(CONDENSER WATER SYSTEM)

CONCEPTUAL ARRANGEMENT

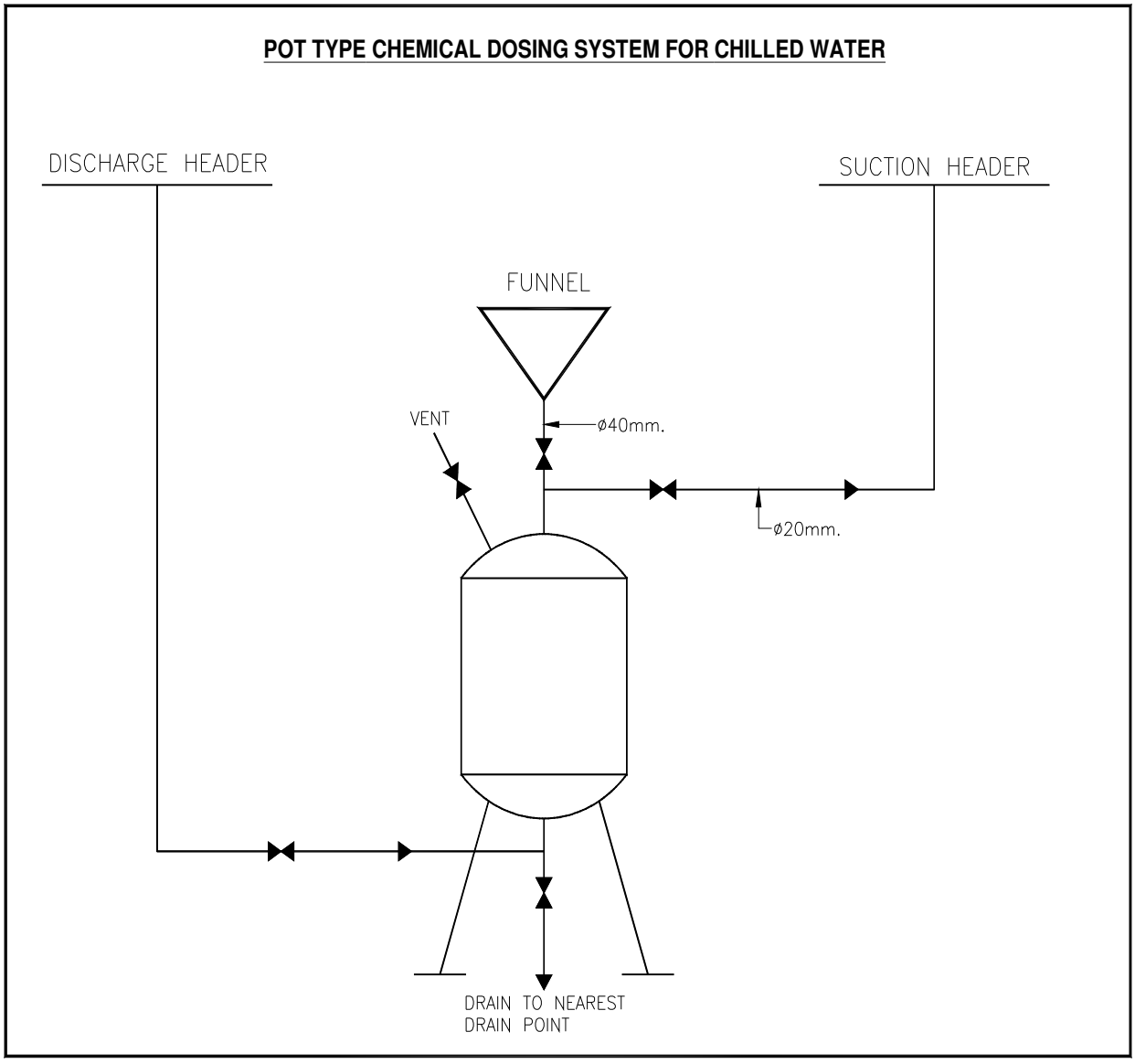



CHEMICAL DOSING SYSTEM FOR COOLING TOWER / CONDENSER WATER
CONTROLLER
ø20mm.PVC/PP LINE
TO SUCTION HEADER
FROM DISCHARGE HEADER
DRAIN LINE 20mm.
FLEXIBLE TUBE (INJECTION LINE)
15mm.SAMPLE LINE
FLEXIBLE TUBE (SUCTION TUBE)
VERTICAL FRAME WITH BASE FOR PUMP MOUNTING S.S.304
① ② ③ ④ ⑤
CHEMICAL TANK MOUNTED ON THE M.S.BASE FRAME
1-AKLINE CLEANING CHEMICAL FOR PRE-CLEANING OF SYSTEM
2-PREVENTIVE TREATMENT CHEMICAL FOR CORROSION AND SCALE
3-PREVENTIVE TREATMENT CHEMICAL FOR BIOLOGICAL FOULING
4-PREVENTIVE TREATMENT CHEMICAL FOR MICROBIAL FOULING
5-PREVENTIVE TREATMENT CHEMICAL FOR MICROBIAL FOULING
STRAINER
BASE FOR CHEMICAL TANK

CHEMCIAL DOSER – POT TYPE FOR CHILLED WATER DOSING

To dose chemicals to the chilled water circuit, a simple pot-type dozer with all the necessary valves and Funnel (tundish) shall be provided. Since chilled water system is closed and doesn't require continuous make-up water as it is required for the condenser water circuit, an automatic dosing system is not required for this circuit.

The following dimensions are indicative only. If the system requires larger or smaller dimensions the water treatment vendor to suggest accordingly.



INITIAL CLEANING AND PREENTIVE TREATMENT FOR CONDENSER & CHILLED WATER SYSTEM

INITIAL FLUSHING

HVAC contractor will thoroughly flush both the condenser water & the chilled systems with water to ensure that all the welding burrs etc. are dislodged from the piping system and until the water quality becomes acceptable for chemical flushing. The water treatment vendor will approve and

advise HVAC contractor whether the system is properly flushed and whether suitable for chemical flushing.

AQB-406 or Equitant

Once the systems are flushed, both the circuits shall be chemically flushed with AQB -406 to ensure that the foreign particulate matter and initial contaminants such as mill scale, cutting oils etc are loosened and dislodged from the systems. This job shall be carried out by the HVAC contractor as to be recommended by water treatment vendor.

FINAL FLUSHING

After chemical flushing is completed, the system will then be finally flushed with fresh water to ensure that the flushing (cleaning) chemical is completely drained from the system and all the loosened matter is thoroughly dislodged and the water is appreciably clean and similar to that of the source water so that the preventive treatment can be started.

ISOLATION OF EQUIPMENTS

During the flushing and chemical cleaning all the major equipments such as; condensers, Chillers, AHUs, FCUs, Pumps etc be isolated (bypassed) and protected against any deposition of solids to be dislodged during the cleaning. If required only one of the system pumps can be used during the cleaning operation or alternatively an additional pump be arranged for this operation to avoid any risk to the system pump.

PREVENTIVE TREATMENT FOR THE CONDENSER WATER CIRCUIT

Preventive Treatment to be done with the following products as to recommended by the vendor.

AQB -5102 or Equitant

This is a liquid form corrosion inhibitor cum deposit control cum scale control agent designed to provide protection to the system against corrosion, scale formation and deposit formation to the condenser water system

AQB – 1000B or Equitant

This is liquid form oxidizing biocide to provide protection to the system against microbial contamination.

AQB – 1520 or Equitant

This is liquid form non-oxidizing biocide to provide protection to the system against microbial contamination including legionnaire species etc.

AQB – 1523 or Equitant

This is liquid form non foaming type non-oxidizing biocide to provide protection to the system against microbial contamination including species SRB and other anaerobic species.

AQB-PH-200 or Equitant (to be dosed as required to control PH)

This is a liquid form PH conditioner, required to control PH if make-up water is used from non BMC source as such make-up water is hard and alkaline.

PREVENTIVE TREATMENT FOR THE CHILLED WATER CIRCUIT

AQB -1200 or Equitant

This is a liquid form corrosion inhibitor cum deposit control designed to provide protection to the system against corrosion, and deposit formation to the chilled r water system

AQB – 1527 or Equitant

This is liquid form non oxidizing biocide to provide protection to the system against microbial contamination.

*24. **ONLINE NON CHEMICAL WATER TREATMENT SYSTEM***

- The unit should be a non-chemical on-line type scale Preventer not requiring any chemicals.
- Non-chemical water treatment system should prevent the formation of hard scale in cooling circuits of air conditioning equipment.
- It should work with a combination of Adsorption, and Turbulence.
- The inner core should be able to convert the hardness salts into colloidal particles.
- The unit should not require any electricity or any other source of energy.
- The unit should not have any recurring, operating and maintenance cost.
- The size of the unit shall be determined based on the water quality and water flow rate.
- The unit shall be installed in the condenser water circuit/ Chiller circuit
- The outer casing should be of stainless steel.
- The company should have method of checking the performance of system through computer simulation
- The unit should be backed by 5 year replacement warranty and one year after sales service.

25.0 HVAC ELECTRICAL SPECIFICATIONS

SPECIFICATION FOR LV SWITCHGEAR –PCC/ MCC/SUB DISTRIBUTION PANELS

1. SCOPE

1.1 This specification covers the design, manufacture, shop floor tests, type and routine tests and delivery of indoor LV switchgear of voltage rating 415 Volts.

1.2 The equipment shall be of type tested design at CPRI /Independent test house for the ratings required as per BOQ. If the type test reports are not available for the required ratings, the test has to be conducted and relevant documents shall be submitted.

1.3 Vendor shall not restrict to the tests mentioned in the specifications. All necessary testes as per code / Client requirement shall be conducted.

1.4 For quantity, type of breaker, short time rating and other specific details, please refer to the technical & specific requirement sheets, BOQ and Drawings enclosed.

1.5 The panel shall be provided with necessary base frames, cut-outs and other necessary items required for complete functioning of the panel.

1.6 All the LT switchgear panels shall be provided with 15% spare compartments/space for adding feeders in future.

1.7 The breaker panels shall be provided with potential free contacts or any other field devices to accept command from BMS and to send status signals to BMS as per IO summary / drawings and apart from the generally provided contacts.

1.8 All Indoor Panels will have Protection of IP54 or Better. All Outdoor Panels will have protection of IP65 or better.

1.9 All ACB's and MCCBs shall be with Microprocessor based release.

2. GENERAL SPECIFICATION:

2.1 **STANDARDS:**

In general the equipment shall conform to all relevant IS/IEC standards. In case of any contradiction between the IS/IEC and this specification, the more stringent of the two shall apply.

a) IS 1248 & 3107 - Direct acting Electrical indicating instruments

b) IS 2147 : 1962 - Degree of Protection of Enclosures for low voltage switchgear

c) IS 11353 : 1985

Part I	:	General rules
Part II	:	Circuit Breakers
Part III	:	Switches, disconnectors, switch disconnectors and fuse combination units
Part IV	:	Contactors and Motor starters
Part V	:	Control circuit devices and switching elements Marking of Switchgear busbars

d) IS 2551 : 1982 - Danger notice plates

e) IS 2959 - AC contactors upto 1000V
f) IS 13947 - AC Circuit Breakers
g) IS 2705 - Current Transformers
h) IS 3156 & 4146 - Potential Transformers.
i) IS 4047 - Specification for air break switches and combination fuse switch units for voltage not exceeding 1000V.
j) IS 6875 - Control switches for voltages upto and including 1000V AC and 1200V DC.
k) IS 1822 - Motor duty Switches
l) IS 12021 - Specification for control transformer.
m) IS 8623 - Factory built assembly of switchgear & control gear for voltage not exceeding 1000V
n) IS 13947 (Part I) - Degree of protection for enclosure
o) IS 3842 - Specification for electrical relays for AC system
p) IS 2208 & 9224 - Specification for HRC fuses.
q) IS 5082 - Wrought Al. and aluminium alloys, bars, rods, tube and sections for electrical purposes.
r) IS 4237 - General requirement for switchgear & control gear for voltage not exceeding 1000V.
s) IS 3231 - Electrical relays for power system protection
t) IS 375 - Marking and arrangement for switchgear bus bars, main connection and control aux. wiring.
u) IS 5578 - Guide for marking of insulated conductors.
v) IS 3618 - Pre-treatment of MS sheets for phosphatising.
w) IS 10118 : 1982 - Code of Practice for selection, installation and Maintenance of switchgear & control gear
x) IEC 60 947 /IS 13947 : 1993 - Low Voltage switchgear & control gear

2.2 DESIGN AND PERFORMANCE REQUIREMENT

2.2.1 All the 415V AC, devices/equipment like bus support insulators, circuit breakers, VTs, etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions:

a. Variation in supply voltage : ± 10%
b. Variation in supply frequency : ± 3%

3. MOTORS & MOTOR CONTROL CENTERS

General-

These specifications cover all types of motors used for chillers, pumps, air handling units, etc. The motor installation, wiring, control shall be carried out strictly in accordance with the specification herein after laid down.

MOTORS-

a) Rating-

The ratings of the motors shall be as required to meet the duty conditions of the appliance to which it is connected but in no case shall be less than that indicated in schedule of quantities. The rating shall be selected on the basis of ambient temperature & allowable maximum temperature rise as specified.

b) Standards-

Codes-

Unless otherwise specified, the induction motors shall conform to the latest edition of relevant Indian. IEC or British Standards. The relevant Indian Standards are-

1.	Induction motors - Three Phase.	IS-325
2.	Measurement and evaluation of vibration of Rotating electrical machine.	IS-4729
3.	Code of Practice for climate proofing.	IS-3202
4.	Degree of Protection provided by enclosures for rotating Electrical Machinery.	IS-4691
5.	Classification of hazardous area for electric equipment.	IS-5572
6.	Flame proof enclosure of electrical equipment.	IS-2148
7.	Method of determination of efficiency of rotating Electrical Machines.	IS-4889
8.	Specification for rotating electric machine.	IS-4722
9.	Construction and testing of electrical apparatus with type of protection “E”.	IS-6381
10.	Designation for types of Construction & Mounting Arrangements of Rotating Electrical machines.	IS-2253
11.	Terminal Marking for Rotating Electrical Machinery.	IS-4728

Designation of Methods of Cooling for Rotating

Electrical Machines. IS-6362

13.	Guide for testing three phase induction motors.	IS-4029
14.	Dimensions of Slide Rails for Electrical Motors.	IS-2968
15.	Industrial Platinum Resistance thermometer sensors.	IS-2848
16.	Method of marking for identifying electrical equipments for explosive atmosphere.	IS-8241

All motors shall comply with IS- 325, in respect of general requirements and performance. Motors shall also confirm to IS- 1231, for foot- mounted motors.

c) In general all the motors above 1 hp. shall be 3 phases unless otherwise specified. Fhp motors may be either 3 phase or single phase as required.

d) Motors shall run at all loads without appreciable noise or hum. Motors shall be one of the following design and as more specifically specified in equipment schedule-

i. Squirrel cage,
ii. Wound Rotor
iii. Totally enclosed
iv. Totally enclosed, fan cooled (T.E.F.C).

v. Screen Protected Drip Proof (S.P.D.P.).

Winding of motors shall be class "B" insulated and fully tropicalised.

e) Motors shall be rated for continuous duty as defined in IS- 325. All motors shall have suitable torque characteristics as required by the duty of driven equipment. Motors shall be suitable for operation on 400+/-10% V, 3 phase, 50 HZ, AC supply (or 230 V single phase 50 HZ, AC supply if required).

f) Motors shall be provided with ball/roller bearings. Bearings shall have ample capacity to deal with any axial thrust. Suitable grease nipples shall be provided for re-greasing the bearing.

g) Motors shall be provided with a cable box to suit the required number of runs of aluminium conductor, PVC insulated, PVC sheathed and steel wire armoured cables.

h) Motors shall be designed to operate successfully under the following conditions of voltage and frequency variation.

1) Where the voltage variation does not exceed ten percent (10 %) above or below normal.

2) Where the frequency variation does not exceed five percent (5 %) above or below normal.

(3) Where the sum of voltage and frequency variation does not exceed ten percent (10%) provided the frequency does not exceed 5% above or below normal.

SWITCHBOARDS

Construction:

Switchboard connection

All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers.

For unit ratings upto 100 amps, FRLSPVC insulated copper conductor wires of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid connections shall be used for all rating above 100A.

All connections, tapings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be zinc plated. Only 8.8 grade nuts and bolts shall be used for busbar connections.

Switchboard Construction and operation

The low-voltage electrical switchboards shall be made up of identified functional volumes including the busbar compartment, switchgear and controlgear component compartment, connection compartment and auxiliaries compartment.

The different busbars shall be the main busbars, distribution busbars and auxiliary busbars.

Busbars shall be made of high conductivity, high strength aluminium alloy, complying with requirements of grade E 91E of IS 5082 – 1981. Design of busbar system shall comply to IS 5578 and IS 11353.

The compartments shall be located inside a metal enclosure with walls providing protection against direct contact with live parts and guaranteeing a degree of protection IP 2X. The frame, the external panels (doors, side and rear panels, tops) and internal elements (ducts) shall be made of minimum 2 mm thick steel sheet metal and load bearing members with 2.5mm and shall be folded and braced as necessary to provide a rigid support for all components and protected by an epoxy-paint coating.

The max height of panel shall be 2300mm including the base channel.

All the panels shall be as per form 3B construction i.e. the Functional Units shall be separated from each other and from the busbars. Terminal shall separated from busbrs But are not sepreted from each other. In case of MCB's, multiple MCB's can be mounted in 1 compartment as per GA drg. approval.

Sheet metal elements in the immediate proximity of high current flow generating potential eddy current shall be made of aluminium.

Drawers or air circuit breakers shall have four different positions: connected, test, disconnected and removed. Withdrawability of upstream and downstream power circuits and of auxiliary circuits shall be total, i.e. in compliance with standard IS – 8326.

The switchboard cover panels shall be removable.

The construction system shall provide a complete set of elements for installing fixed or withdrawable switching and protective devices, measurement devices and control / monitoring devices in the switchboard.

The drawers shall be designed such that the rated degree of protection (IP, as per IS 2147: 1962) is maintained whatever their position (connected, test, disconnected, removed).

Switchboard Compartmentalization

For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alleys.

Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.

For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections.

Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only.

A horizontal wire way shall be provided at the top/bottom to take interconnecting control wiring between vertical sections.

Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables.

Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

Bus Bars

Busbars shall be made of high conductivity, high strength Aluminium of ETP grade. Busbars shall be of rectangular cross sections suitable for full load current for phase bus bars and full rated current for neutral bus bar. Busbar shall be suitable to withstand the stresses of fault level as specified in SLD. The certification for conductivity of the Alumimium shall be made available from third party certifying agency.

The bus bars shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports able to withstand operating temperature of 110°C at regular intervals, to withstand the forces arising from a fault level as stipulated in schedule of quantities. The material and the spacing of the Busbar supports should be same as per the type tested assembly.

The minimum clearances to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as per IS guidelines. The busbar shall be as per current density of Aluminium 0.8 A/Sq.mm Cross Section area.

The busbar shall be housed in separate compartment and shall be isolated with 3 mm thick FRC/Polycarbonate sheet to avoid any accidental contact. The busbar shall be arranged such that min. clearances between the busbars are as mentioned below:

Between phases – 27 mm minimum
Between phase and neutral – 25 mm minimum
Between phase and earth – 25 mm minimum
Between neutral and earth – 23 mm minimum

The busbar and interconnection shall be insulated with heat shrinkable PVC sleeves and shall be colour coded in Red / Yellow / Blue / Black / Green to identify the three phases / neutral and earth of the system. The busbar shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports at sufficiently close intervals to prevent busbar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 50KA RMS symmetrical fault for 1 sec and peak short circuit withstand of 105KA minimum.

All busbar connections shall be done by drilling holes at factory in busbars and connecting by chromium plated bolts and nuts. Additional cross section of busbar shall be provided in all

panels to cover up for the holes in the busbars. Spring and flat washers shall be used for tightening of bolts.

Instrument Accommodation

All voltmeter and ammeter and other instruments shall be flushed mounted type of size 96 X 96 mm conforming to class 1.0 to IS 1248 for accuracy. All voltmeter shall be protected with suitable SCPD device.

Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment (in case of ACB) door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.

For MCCBs, instruments and indicating lamps can be provided on the compartment doors.

The current transformers for metering and for protection shall be mounted on the solid Aluminium busbars with proper supports.

On all the incomers of switch boards ON/OFF indicators lamps shall be provided suitable for operation on AC 230 volts supply. All lamps shall be protected with proper protection device. Where phase indicator lamps are to be provided.

Wiring

All wiring for relays and meters shall be with FRLS PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq. mm. Runs of wires shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables shall be suitable for withstanding 105 deg C.

Space Heaters

Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5º C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

Ventilation Fans

The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 4500 amp and above. The fan shall be interlocked with switchgear operation. The degree of enclosure protection to be maintained even with Fans. The fans shall be fitted with temperature sensors for automatic operation.

Earthing

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids. Minimum size for earth bus shall be 2 strips of 25 X 3 mm Copper.

Sheet Steel Treatment and Painting

Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphating process . Final paint coat of oven baked powder coating, of minimum 50 micron thickness, of sheet approved by Engineer-in-Charge shall then be provided.

Name Plates and Labels

Identification labels of Aluminium with black base and silver fonts shall be provided on all feeders / lamps / panel name plate / relays / contactors etc. These shall indicate the feeder number and feeder designation also along with rating of the switchgear. Sample for the same shall be first approved by engineer.

Installation

Splices shall be implemented to ensure the electrical continuity of the horizontal busbars, auxiliary buses and the protective conductor between adjacent sections.

It shall be possible to secure the sections to a floor that is flat to within 2 mm/m:
by anchoring directly to a concrete floor using anchor bolts;
by securing to ordinary metal profiles.
Extensions to the low-voltage electrical switchboards shall be possible on either side (right or left).

Protection and Safety

The low-voltage electrical switchboards shall ensure the safety of life and property as well as provide a high level of continuity of service.

- switching safety shall be ensured by a mechanical device preventing on-load withdrawal & on-load access to live parts, except by strictly following a defined procedure & using defined tools.
- operating safety shall be ensured by the use of compartments in compliance with standard IEC 60439-1 and according to form types 3b.
- current interruption shall be of the "visible break isolation" or "positive contact indication" type as defined by standard IS 13947: 1993.

In view of reducing the risk of electrical shock:

- power and control circuits shall be separate and completely isolated;
- auxiliary circuits shall be of the extra-low voltage type.

The low-voltage electrical switchboards shall be equipped with two types of mechanical locking compatible with the different positions of drawers. The locking system shall be partially mobile and implement three padlocks.

Optionally, the safety of persons shall be enhanced by a version complying with the requirements of standard IEC 61641 concerning the propagation of an arc inside electrical switchboards. Test certificates shall be available.

Provisions must be made, around the equipment critical zones, for visual/infrared inspection during equipment operation, with respect to operator safety as shown in 1.4.1.

Earthed metal or insulated shutters shall be provided between drawout and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP 2X.

Overall IP rating of panel shall be IP 54.

Internal Components:

The panels shall be equipped complete with all type of required number of air circuit breakers, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings. Components necessary for proper complete functioning of the panels but not indicated on the drawings shall be supplied and installed on the panels.

All part of the panels carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the panels.

All units of the same rating and specifications shall be fully interchangeable.

L. T. Switchgears:

General:

The type, size, and rating of the components shall be as indicated on the relevant single line diagrams (SLDs) and BOQ.

All switchgear components from PCC to final distribution must comply with total discrimination with full breaking capacity. Necessary charts/ discrimination table shall be submitted by switchgear manufacturer in line with SLD.

Miniature Circuit Breaker (MCB):

Miniature circuit breakers shall be quick make and break and break type conform with IS: 8828 (1996). The housing of MCBs shall be heat resistant and having high impact strength. The fault current of MCBs shall not be less than 10 kA, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faulty current.

The MCB contact shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided

with magnetic fluid plunger relay for over current and short circuit protection. The over load or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested and certified as per Indian Standard, prior to Installation.

Fuse:

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with IS : 2000-1962 and having rupturing capacity of not less than 35 MVA at 415 Volts.

Air Circuit Breaker:

General

The circuit breakers shall be of the air break type, robust and compact design suitable for indoor mounting and shall comply with the requirement of IS/IEC: 60947 :Part 2 (Latest). Rupturing capacity shall be as stipulated in Schedule of quantities. Heat loss per pole shall be low.

The breaker shall comply with the isolation function requirement of IEC 60 947-2 section 7.12 to marked as suitable for isolation / disconnection to facilitate safety of operating personal while the breaker is in use.

The breaker shall provide class II insulation between the front panel and internal power circuits to avoid any accidental contact with the live main current carrying path with the front cover open.

Protective devices, metering, CTs, PTs, push buttons and indicating lamps shall be provided as per schedule of quantities.

For all ACB's Ics=Icu=Icw.

Constructional Features

The ACB shall be 3 or 4 pole with modular construction and moulded Housing, draw out, manually or electrically operated version as specified and shall be capable of providing short circuit, overload and earth fault protection through micro processor based unit.

The Circuit Breaker cradle shall be designed and constructed to permit smooth withdrawal and insertion. The movement shall be free of jerks, easy to operate and positive.

Four Pole ACBs shall have 100% Neutral Rating. Four pole ACBs shall also have 4th pole protection adjustable at site as per size of neutral conductor i.e. Half neutral/full neutral/no protection.

All current carrying parts in the breaker shall be silver plated and suitable arcing contacts shall be provided to protect the main contacts which shall be separate from the main contacts and easily replaceable. In addition, Arc chutes shall be provided for each pole, and these shall be suitable for being lifted out for the inspection of the main and the arcing contacts.

The circuit breaker shall have indication of mechanical wear of contacts enabling visible indication of contact life.

Self aligning cluster type isolating contacts shall be provided for the Circuit Breaker, with automatically operated shutters to screen live cluster contacts when the Breaker is withdrawn from the cubicle. Sliding connections including those for the auxiliary contacts and control wiring shall also be of the self aligning type. The fixed portion of the sliding connections shall have easy access for maintenance purposes.

All ACB's control wiring shall be accessible from the front along with all accessories ,shunt closing, under voltage releases shall also be fittable from front.

There shall be flexibility in changing the types of terminals at site to suit the bus bar orientation if required.

The cubicle for housing the Breaker shall be free standing dead front pattern, fabricated from the best quality sheet steel.

Operating Mechanism

The Circuit Breaker shall be trip free with independent manual spring operated or motor wound spring operated mechanism as specified and with mechanical ON/OFF indication. The operating mechanism shall be such that the circuit breaker is at all times free to open immediately the trip coil is energised. The breaker shall be provided with in built antipumping mechanism.

Motors, their electrically operated auxiliary equipment, closing and tripping coils shall operate satisfactorily between 85% to 110% of the rated supply voltage.

The Breaker operating mechanism shall store energy for O-C-O operation and shall not in any case remain closed during this cycle. After failure of power supply to motor at least one O-C-O operation shall be possible.

The closing time shall be less than or equal to 70 millisec to ensure taster closing of the breaker.

The operating handle and mechanical trip push button shall be at the front of and integral with the Circuit Breaker.

There shall be mechanical/Electrical indicator on the front panel for 'Ready to close' situation for the breaker by checking all interlockings.

The Circuit Breaker shall have the following four distinct and separate positions which shall be indicated on the face of the panel.

"Service" -- Both main and secondary isolating contacts closed
"Test" -- Main isolating contacts open and secondary isolating contacts closed
"Isolated" -- Both main and secondary isolating contacts open
"Maintenance" -- Circuit Breaker fully outside the panel ready for maintenance

Electrical endurance with maintenance shall be greater than 5000 cycles up to 4000 amps, and 1500 cycles for values greater than 4000 amps.

Protections

The Microprocessor Releases unit shall be provided on circuit breaker for Long Time (Over load), Short Time (Short circuit) and Earth fault protection all with adjustable setting and adjustable time delay by dial. Release shall also have Instantaneous Protection, True RMS sensing with EMC/EMI Compatibility.

The ACB's shall be equipped with under voltage trip only on those used as main incomer of all sources, bus coupler and inter connector. The trip devices shall be direct acting.

Thermal Memory - When the breaker shall re-close after tripping on overload, then the thermal stress caused by the overload if not disspated completely, shall get stored in the memory of releases and this thermal memory shall ensure reduced triping time in case of subsequent overloads and earth fault. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

Display - All breakers Releases shall have a LCD display of currents of all the phases (I1, I2, I3) and Neutral (In-for 4P). It shall also have Bar Graph to indicate individual phase loading and identify whether all phase are evenly loaded. If required, it should be possible to add a communicating port (RS 485) to the MP releases without changing the releases. The releases shall have indications through LED's for Over load, short circuit and earth faults for fault differential and fault diagnosis.

All the Incomer & Bus coupler ACBs shall be provided with remote operation facility/ Modbus from BMS – ON/OFF, shunt trip release and motorised reclosing, communication modules providing LAN interface with BMS and draw out pattern with test facility provision. All other ACBs shall be provided with ON/ OFF/ TRIP control/ status to BMS/ PLC thru hard wire.

Zone Selective Interlocking – The releases shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stress produced during fault conditions and thus minimizes the damage to the system.

Circuit Breaker Interlocking

Sequence type strain free interlocks shall be provided to ensure the following:

It shall not be possible for the Breaker to be withdrawn from the cubicle when in the "ON" position. To achieve this, suitable mechanism shall be provided to lock the Breaker in the tripped position before the Breaker is isolated.

It shall not be possible for the Breaker to be switched "ON" until it is either in the fully inserted position or, for testing purposes, it is in the fully isolated position.

It shall not be possible for the Circuit Breaker to be plugged in unless it is in the OFF position. ACB's Shunt and closing coils shall be continuous Duty cycle.

A safety latch shall be provided to ensure that the movement of the Breaker, as it is withdrawn, is checked before it is completely out of the cubicle, thus preventing its accidental fall due its weight.

Mechanical and electrical antipumping devices shall be incorporated in the ACB's as required.

The Breaker cannot be put into service position with the compartment door open.

Breaker compartment door cannot be opened when the Circuit breaker is in the Service/Test position.

Circuit Breaker Auxiliary Contacts

The Circuit Breaker shall have suitable free / minimum 6 NO/NC auxiliary contacts rated at 16 amps 415 volts 50 Hz. These contacts shall be approachable from the front for connecting all external wiring from the front. They shall close before the main contacts when the Circuit Breaker is plugged in and vice versa when the Circuit Breaker is Drawn Out of the cubicle.

Earthing

The frame of the Circuit Breaker shall be positively earthed when the Circuit Breaker is racked into the cubicle.

Type Test Certificates

The Contractor shall submit type test certificates from a recognised test house for the Circuit Breakers offered.

Moulded Case Circuit Breaker:

General

Moulded-Case Circuit Breakers (MCCB) shall comply with IS /IEC 60947 Part 2 (Latest) standards.

they shall be of utilisation category A on all the operational voltage range – till 250A and category B on all the operational voltage range – for any rating with adjustable short time delay (if specified) with a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) up to 500V for the greater ratings

they shall have a rated operational voltage of 690 V AC (50/60 Hz)

they shall have a rated insulation voltage of 800 V AC (50/60 Hz)

they shall be suitable for isolation, as defined by IS/ IEC 60947 Part 2 (Latest) for the Overvoltage Category IV for a rated insulation voltage up to 690 V .

MCCBs shall be designed according to Eco-design complying with ISO 14062 Especially MCCB's materials shall be of halogen free type. They shall be supplied in recyclable packing complying with European Directives.

The manufacturer shall implement non polluting production processes that do not make use of chlorofluorocarbons, chlorinated hydrocarbons, ink for cardboard markings, etc

A safety trip shall provide advanced opening to prevent connection and disconnection of a closed circuit breaker

MCCBs shall be designed for both vertical and horizontal mounting, without any adverse effect on electrical performance. It shall be possible to supply power either from the upstream or downstream side

MCCBs shall provide class II insulation between the front and internal power circuits

Construction, Operation, Environment

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting. material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries

All poles shall operate simultaneously for circuit breaker opening, closing and tripping.

MCCBs shall be actuated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.

In order to ensure suitability for isolation complying with IS 13947: 1993:

the operating mechanism shall be designed such that the toggle or handle can only be in OFF position (O) if the power contacts are all actually separated

in OFF position, the toggle or handle shall indicate the isolation position.

Isolation shall preferably be provided by a double break on the main circuit

MCCBs shall be able to receive a device for locking in the “isolated” position, with up to 3 padlocks, Ø8 maximum.

MCCBs shall be equipped with a “push to trip” button in front to test operation and the opening of the poles.

MCCB rating, “push to trip” button, performances and contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard.

Current Limitation, Discrimination, Durability

All the MCCBs shall be equipped with a tripping unit microprocessor type.

MCCBs shall comprise a device, designed to trip the circuit-breaker in the event of high-value short-circuit currents. This device shall be independent of the thermal-magnetic or electronic trip unit.

MCCBs, the current ratings of which are identical with the ratings of their trip units, shall ensure discrimination for any fault current up to at least 35 kA rms, with any downstream circuit-breaker having a current rating less or equal to 0.4 times that of the upstream circuit-breaker.

The electrical durability of MCCBs, as defined by IS 13947: 1993 standard.

MCCBs shall be equipped with a self-test of the connection between the electronic trip unit, the current transformers and the actuator, that will not cause the circuit-breaker to trip. The self-test will be of positive logic and visible through the flashing of a green LED in case the self-test occurred correctly and the extinction of the LED in case the self-test failed.

The MCCB shall trip in case the environmental conditions of the circuit-breaker get out of their specified range. However, it will be possible to overrule this feature.

Auxiliaries and Accessories

It shall be possible to equip MCCBs with a motor mechanism for electrically controlled operation if specified in SLD. An "auto/manual" switch in front shall, when set to the "manual" position, lock out electrical control; when set to "auto", lock out the manual control; remote indication of "manual" or "auto" mode shall be possible. It shall also be possible to seal the access to the "auto" control.
Closing shall take place in less than 80 ms.

Following tripping due to electrical faults (overload, short-circuit, earth fault if mentioned in SLD), remote reset shall be inhibited.

It shall however be possible if opening was initiated by a voltage release.

The operating mechanism shall be of the stored-energy type only

The addition of a motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics:

only three stable tripping mechanism positions (ON, OFF and TRIPPED) shall be possible with the motor mechanism

suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module

MCCBs shall be designed to enable safe on-site installation of auxiliaries such as voltage releases (shunt and under voltage releases) and indication switches as follows:

they shall be separated from power circuits

all electrical auxiliaries shall be of the snap-in type and fitted with terminal blocks

all auxiliaries shall be common for the entire range

auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself

the addition of auxiliaries shall not increase the volume of the circuit breaker.

The addition of a motor mechanism module or a rotary handle, etc., shall not mask or block device settings

It shall be possible to assemble earth fault protection moulded-case circuit breakers by adding a residual current device (RCD) directly to the circuit breaker case. The resulting device shall:

comply with IS 13947: 1993 standard

be immunised against nuisance tripping

be capable of working normally down to -25 °C ambient temperature

operate without an auxiliary power supply, i.e. it shall be capable of operating normally on any 2-phase or 3-phase power network with a voltage between 200 V and 440 V, and of tripping the circuit-breaker even in the event of voltage dips down to 80 V

It shall be possible to equip MCCBs with devices indicating faults without tripping the circuit breaker

Protection Functions

General Recommendations

MCCBs with ratings up to 160 A shall be equipped with fully interchangeable trip units in order to ensure the protection against overload and short-circuit. The trip units shall be microprocessor based release without earth fault/ with external earth fault module, wherever specified in BOQ.

MCCBs with ratings 160 A and above shall be equipped with microprocessor based trip units with protection against overload and short-circuit & inbuilt earth fault.

Common Features

Electronic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings

Electronic trip units shall comply with IS 13947: 1993 standard (measurement of rms current values, electromagnetic compatibility, etc.)

Protection settings shall apply to all circuit breaker poles

The trip units shall not augment overall circuit breaker volume

All electronic components shall withstand temperatures up to 125 °C.

Mircroprocessor Trip Units

Characteristics

- Long time protection (LT)
Selectable Ir threshold settings from 40 % to 100 % of the trip unit rating
- Short time protection (ST)

Isd threshold shall be adjustable from 1,5 to 10 times the thermal setting Ir,
The time delay shall be either adjustable or fixed at 40 ms,
- Instantaneous protection

The threshold shall be either adjustable or fixed (starting from 1.5 times In and up to a value between 11 and 15 times In, depending on the rating)

Four-pole devices shall be equipped for neutral protection:
as standard with a 3-position setting : - neutral not protected - neutral tripping threshold equal to half the phase value - neutral threshold equal to the phase value

if required by harmonic 3 neutral current circulation with a specific 4-position setting - neutral not protected - neutral tripping threshold equal to half the phase value - neutral threshold equal to the phase value - neutral setting according to the rating of the phases in a ratio 1.6 (Oversized Neutral).

The above mentioned characteristics if vary, according to Approved Manufacturers Standards shall be accepted subject to approval of Engineer-In-Charge

Load Monitoring Function

The following monitoring functions shall be integral parts of electronic trip units:
- 2 LED for load indication, one lighted above 90 % of Ir, and one lighted above 105 % of Ir
- a test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.

Thermal Memory

In the event of repeated overloads, the electronic trip unit shall optimise protection of cables and downstream devices by memorising temperature variations.
Options:

It shall be possible to install all options for the electronic trip unit:
- high-threshold earth-fault protection,
- auxiliary contact to indicate the cause of tripping (long time, short time, instantaneous, earth fault if requested),
- data transmission via a BUS, in particular all the trip unit settings, current measurements for each phase, tripping causes, circuit breaker status.

It shall be possible to install a specific module that can provide the data transmission, in particular all the trip unit settings, all electrical parameters (current, energy, THD, voltage, etc.) measurements for each phase, tripping causes, circuit breaker status, control and alarms.

Software that allows these data to be analysed on PC shall be provided by the manufacturer.

2.13.6 Contactors:

The contactor shall meet with the requirements of IS: 2959.
Contactors shall be air break and electromagnetic type rated for uninterrupted duty as defined in relevant IS.
The main contacts shall be of silver or silver alloy.
The insulation for the coils shall be of class ‘f’.

Each contactors shall be provided with 2 normally open and 2 normally closed auxiliary contacts.
The contactors shall be in accordance to type 2 co-ordination for short circuit protection.
The contactor shall be suitable for uninterrupted duty (AC3) category.
The electrical and mechanical endurance shall be as specified in IS code.

2.13.7 Multi Function Meter:

Flush mount 96 x 96 x 80 mm load manager type CONSERV EM 6400 or equivalent meter of accuracy class 1 as per IS 13779 shall be provided. The meter shall be accurate on distorted waveforms; simultaneous sampling of voltage and amperes shall be done. It shall have low burden on PT and CT shall have bright display, shall view 3 parameters together shall have auto scaling from kilo to mega to giga units, shall have programmable CT, PT ratios with built in phase analyser. Auto scrolling shall be programmable as per user choice and communication with PC; PLC DCS shall be possible through RS 485 serial port. It shall be dust proof, tamper proof with data import export option and 10 years back up of integrated data.

Parameters to be monitored shall be Frequency, Line to line and average and line to neutral and average voltage, phase wise and average current, phase wise and total KVA, KW and P.F. reading and KWH monitoring.

User programmable facility for delta 2e and star 3e measurement, C.T. and P.T. ratios, sliding window auto sync. And auto scrolling of parameters shall be available.

Sensing shall be 3 phase, 4 wire measuring True RMS with voltage input range of 110 to 415 V nominal and current input of 5 amps or 1 amps as per field configuration. Current range shall be from 50 mA to 7.5 A and burden on PT or CT shall be app 0.2 VA.

Accuracy for kW / kWh shall be as per IS 1377 / CBIP88 and for all other parameters shall be +/- 0.5% of full scale + 0.5% of reading + 1 digit. Digital readout shall be of 3 rows of 4 digits each (12.5 mm size) with 7 segments bright red LED. Input frequency shall be 50Hz / 60Hz +/- 5%. Power factor range shall be 0.5 lag – unit – 0.8 lead.

Resolution for power parameters shall be for 4 digits and energy parameters shall be 8 digits. Display update shall be at every 15 seconds for demand parameters and 1 sec for other parameters. Display sequence shall be parameter followed by value. Temperature range shall be 0-50oC and humidity <95% non-condensing.

Display pages shall be as follows:

Instantaneous – VLL, A avg., F
VLn, A avg., F
KVA, kW, PF

Individual pages of above parameters.

Integrated - kVAh
KWh
Run hours
On hours
Interruption

Note: It is the responsibility of the contractor to co-ordinate with the suppliers and IBMS/ other concerned agencies regarding compatibility of the energy meter/ multi function meter with IBMS and Electronic billing/ tenant billing software.

Current Transformer:

Where called for, CT's shall provided for current measuring. Each phase shall be provided with separate CT of class I accuracy and VA burden as shown in SLD for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 - 1964 as amended up to date.

Separate CT for each protection devices and instrumentation device shall be provided.
The CT shall be able to withstand max short time withstand current indicated for the assembly.

The CT shall be cast resin type.

Test links at secondary – to facilities testing of instruments / meters and protection device.

Push Button & Indicating Lamp :

The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps continuous current rating. The actuator shall be of stranded type and colour as per its usage for ON, OFF and Trip.

Indicating Lamp shall be LED type and shall supplied complete with translucent covers to diffuse the lamp light. Indicating lamps shall be part of push buttons where ever both are reqruied and shall have testing facilities. Protection in form of MCB / HRC fuse shall be provided for the lamps.

Colour shade for the indicating lamps shall be as below:

ON indicating lamp	:	Green
OFF indicating lamp	:	Red
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow, and Blue.

Selector Switches:

Selector Switches shall be of the heavy duty rotory type, with plates clearly marked to show the operating position. They shall be of the semi-flush mounted type with only the front plate and operating handle projecting.

Circuit breaker control switches shall be of the spring return to neutral type.

MOTOR PROTECTION CIRCUIT BREAKERS

MPCB shall confirm to IS 13947 / IEC 947

The MPCB shall have the mechanism that the contactor trips in the event of overload and MPCB trips in the event of short circuit fault.

The MPCB / contactor / relay selection shall be as per type 2 co-ordination upto 7.5KW DOL and total co-ordination for motors above 7.5KW.

Direct On-Line Starters

These starters shall have heavy-duty air break contactors of suitable rating. These shall be total coordination type based on combination of MPCB and contactor.

These starters shall be complete with adjustable overload relays on all three phases, single phase preventing device and under voltage release. The starters should be "hand reset" type.

The "No Volt Coil" of these starters shall be 220 Volts + 10% - 15% (wide band type) whenever any controls on safety devices are connected in the starters circuits, otherwise standard 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required.

Automatic Star Delta Starters

These starters shall have heavy duty air break contactors of suitable ratings along wth an adjustable timer to automatically switch the motor connections from star to delta connections. These shall be type-2 co-ordination type based on selection chart of manufacturer with MCCB contactor, timer etc.

Each starter shall be complete with adjustable overload relays on all three phases and under voltage release. The starters should be "hand reset" type.

The "No volt coil" shall be of 220 volts + 10% - 15% (side band type) rating wherever any controls of safety device are connected in the starter circuit, otherwise standing 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required.

Workmanship

The contractor shall erect the panel at site in co-ordination with the supplier if required. He should check for loose ends on the part of the supplier and shall inform client and consultant for the same. Physical and continuity tests shall be carried out by contractor. Also the field tests carried out by the supplier shall be recorded by the contractor.

Mode of measurement

Contractor shall be paid for one panel erection.

CABLE TRAYS

Cable trays shall be fabricated from Hot Dip GI and channels of 14 gauge and shall be powder coated with 7 tank process if specified. The cable tray shall be double bend, ladder/perforated type. The design shall be ladder type with optional cover.

Trays shall not have sharp edges, burrs or projections injurious to cable insulation. Trays shall include fittings such as bends, risers etc. for changes in direction and elevation. Each run of cable tray shall be completed before laying of cables. Cable trays shall be exposed and accessible.

Trays shall be supported adequately at minimum 1m distance from the building structure by means of galvanized (as specified) MS structural members secured to the structure by dash fasteners or by grouting. The entire cable tray system shall be rigid. Cost of support arrangement shall be included in the rates quoted for supply and installation of trays. Complete details of this support arrangement shall be shown in working drawings to be prepared by the contractors and submitted for approval of employer's representative before execution. Works shall be carried out only as pr approved working drawing.

LT POWER & CONTROL CABLES AND CABLE TERMINATION:

1. SPECIFICATIONS

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in the original drums with manufacturer's name, size and type clearly written on the drums.

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the client.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practise.

2. STANDARDS

The cables shall comply with the latest edition of the following standards:

IS:1554	-	PVC insulated heavy duty cables
IS:7098 (Part –I)	-	XLPE Cables – LT
IS:7098 (Part -II)	-	Cross-linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV upto and including 33 kV.
IS:1255 – 1983	-	Code of practice for installation and maintenance of power cables.
IS:8130	-	Conductors for insulated electric cables and flexible cords.
IS:5831	-	PVC insulation and sheath of electric cables
IS:5891-1970	-	Recommended short circuit rating of high voltage P"VC cables
IS:3961-1987	-	Recommended current rating
IS:3975	-	Mild steel wires, strips and tapes for armouring of cables.
IS:2633	-	Methods of testing weight, thickness and uniformity of coating on hot dipped galvanized articles.
IS:209	-	Specification of zinc.

IS:3961 (Part-II)	-	Recommended current ratings for PVC insulated and PVC sheathed heavy duty cables.
IS:10418	-	Wooden drums for electric cables.
IEC:540 & 540A	-	Test methods for insulation and sheaths of electric cables and cords.
IS:10462 (Part-I)	-	Fictitious calculation methods for determination of dimensions of protective covering of electrometric and thermoplastic insulated cables.
IS:10810 (Part 58)	-	Oxygen Index test
BS 7655 LTS2	-	Flammability Characteristics of Cables
IEC 60092-SHF-1	-	Flammability Characteristics of Cables
IEC-332	-	Flammability Characteristics of Cables
SS4241475 class F3	-	Flammability Characteristics of Cables
ASTM-D-2843	-	Determination of smoke generation of outer sheath under fire

3.0 GENERAL CONSTRUCTION:

3.1 The cables shall be suitable for laying in trays, trenches, ducts and conduits and for underground buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.

3.2 Outer sheath of all FRLS PVC and FRLS XLPE cables shall be black in colour and the minimum value of oxygen index shall be 29 at 27 + 2 deg. C. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.

3.3 Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing shall be legible and indelible.

3.4 The overall diameter of the cables shall be strictly as per the values declared in the technical information furnished along with bids subject to a maximum tolerance of + 2 mm.

3.5 PVC / Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand meter length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.

4.0 1.1 kV Power & Control Cables

4.1 All power / control cables for use on medium voltage systems shall be heavy-duty type, 1100V insulated, FRLS XLPE for LT and FRLS PVC for Control Cables.

4.2 The conductors shall be 'stranded' for both aluminium and copper cables. Conductors of nominal area less than 25 sq.mm shall be circular only. Conductors of area 25 sq.mm and above may be circular or shaped. Cables with reduced neutral conductor shall have sizes as per tables 1 of IS 1554 (Part-I).

4.3 The thickness of insulation and the tolerance on thickness of insulation shall as per table 2 of IS:1554 Part-I. Control cables having 6 cores and above shall be identified with prominent and indelible English numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for cables upto 5 cores shall be as per Indian standards.

4.4 Armouring for multi-core cables shall be by single round galvanized steel wires where the calculated diameter below armouring does not exceed 13mm and by galvanized steel strips where this dimension is greater than 13mm. Requirement and methods of tests for armour material and uniformity of galvanization shall be as per IS:1554 (Part-I). Armouring for single core cable shall be with H4 grade hard drawn aluminium round wire of 2.5 sq.mm diameter.

A. CONDUCTOR :

Uncoated, annealed copper / aluminium, of high conductivity, upto 4 mm2 size the conductor shall be solid and above 4 mm2 the conductors shall be concentrically stranded as per IEC : 228.

CORE INDENTIFICATION :

Two core	:	Red and Black
Three core	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green, Yellow for earthing.

Black shall always be used for neutral.

ASSEMBLY :
Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

ARMOUR :
Galvanised steel flat strip / round strips applied helically in single layers complete with covering the assembly of cores.

For cable size upto 10 sq mm	: Armour of 1.4 mm dia G.I. round wire
For cable size above 10 sq mm	: Armour of 4 mm wide 0.8 mm thick GI strip

SHEATH :
ST -2 PVC along with polypropylene fillers to be provided.
Inner sheath shall be extruded type and shall be compatible with the insulation provided for the cables.

Outer sheath shall be of an extruded type layer of suitable FRLS GRADED PVC material compatible with the specified ambient temp. of 50oc and operating temperature of cables. The sheath shall be resistant to water, ultra violet radiation, fungus, termite and rodent attacks. The colour of outer sheath shall be black.

Sequential length marking along with size and other standard parameters shall be required at every 1.0 mtr on the outer sheath.

TESTING :

Finished cable tests at manufacturers works : The finished cables shall be tested at manufacturer's works for all the routine tests for all the length and size of cables to be delivered at site and the certificate for the same shall be furnished to client. If required the cables shall be tested in presence of the client's representative.

Voltage test : Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.
Conductor resistance test : The D.C. resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20oc to check the compliance with the values specified in the Is 8130 – 1976.
Cable tests before and after laying cables at site :
Insulation resistance test between phases, phase to neutral and phase to earth.
Continuity test of all the phases, neutral and earth continuity conductor.
Earth resistance test of all the phases and neutral.

All the tests shall be carried out in accordance with the relevant IS code of practise and Indian Electricity Rules. The vendor shall provide necessary instruments, equipments and labour for conducting the above tests and shall bear all the expenses in connection with such tests. All tests shall be carried out in the presence of client and the results shall be prescribed in forms and submitted.

CABLE MARKING :

The outer sheath shall be legibly embossed at every meter with following legend :

ELECTRIC CABLE : 1100 V, SIZE :___C X ____ MM2 with Manufacturers name, year of manufacturing and ISI symbol.

SEALING DRUMMING AND PACKING :

After tests at manufacturer's woks, both ends of the cables shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall be supplied in length of 500 mtrs or as required in non-returnable drums of sufficiently sturdy construction.

Cables of more than 250 meters shall also be supplied in non-returnable drums.

The spindle hole shall be minimum 110 mm in diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the Englist literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type, and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

CABLE TERMINATION:

Cable terminations shall be made with aluminium crimped type solder less lugs for all aluminium cables and stud type terminals. For copper cables copper crimped solder less lugs shall be used.
Crimping shall be done with the help of hydraulically operated crimping tool.
For joints where by cable is with aluminium conductor and busbars are aluminium, bimetallic lugs shall be used with compound. CUPAL type of washers shall be used.
Crimping tool shall be used for crimping any size of cable.

CABLE GLANDS:

Cable glands shall be of brass double compression type for indoor and outdoor locations.

FERRULES:

Ferrules shall be of self-sticking type and shall be employed to designate the various cores of the control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

CABLE JOINTS:

Kit type joint shall be done and filled with insulating compound. The joint should be for 1.1 KV grade insulation.

MICC CABLES:

1. The cable shall be MICC (Mineral Insulated copper Conductor) cable confirming to British standard (BS: 5839, BS: 6387, BS 8434 & BS: 60702) (Latest Edition)
2, The cable shall have opening voltage grade of 750V and the outer copper sheath should be of seamless technology to ensure zero moisture ingress during the process of manufacturing.
3, The cable shall withstand temperature minimum 950 degree C for 3 hours Fire rated as per BS: 6387
4, The cable shall be LSZH (Low Smoke Zero Halogen) CWZ type, LPCB approved. As per BS 8434, all three tests of C, W & Z category should be performed on one single sample of cable and in no way these 3 tests should be done on 3 different samples.
5, The cable should have a life expectancy in excess of 100 years.
6, The cables shall be connected to the various devices with proper termination kits/glands. Appropriate glands shall be provided where the cable enters the junction box.
7, Cables are to be supplied along with all accessories, crimped termination etc. Cable is to be laid by the Trained & Experienced personnel only.
8, The cable when running in outdoor area shall not be taken overhead. It shall be laid underground according to IS 1255-1983 (Latest Edition)
9. The successful bidder shall submit an authorization letter from manufacturer assuring their technical & after sales service support for the project. However, the quality of material will be the responsibility of OEM.
10. The manufacturer shall have proper sales office and well established service centre in India.
11. The manufacturer should have supplied similar type of cables in the government organizations and a performance certificate from the organization shall be submitted.
12. The manufacturer shall have adequate no. trained personnel, based in india, who are specialized for termination and installation of MICC cables, which is specialty of this cable.
13. The delivery of material at site should not take more than 3 months after approval/ confirmed order.

B. WORKMANSHIP

Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the Contractor shall mark it out on the drawings and also on the site and obtain the approval of the CLIENT AND/OR ITS ARCHITECT before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

Cables shall be laid on walls, cable trays, inside shafts or trenches. Saddling or support for the cable shall not be more than 500 mm apart. Plastic identification tags shall be provided at every 30 m.

Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc unless marked on drawing by architect / consultant. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 10 meters and at all loop points.

All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. Cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have compression type lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position, so that no rainwater may enter the building. After the cables are tested the pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry watertight.

Testing : MV cables shall be tested upon installation with a 500 V Meggar and the following readings established:
Continuity on all phases.
Insulation Resistance.
between conductors.
all conductors and ground.
All test readings shall be recorded and shall form part of the completion documentation.
Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool. Proper insulation tape shall be applied at the cable and lug joint.

Format for cable testing certificate :

a. Drum no. from which cable is taken :
b. Cable from _____ to _____
c. Length of run of this cable _____ mtr
d. Insulation resistance test
between core 1 to earth _____mega-ohm
between core 2 to earth _____mega-ohm
between core 3 to earth _____mega-ohm
between core 1 to core 2 _____mega-ohm
between core 2 to core 3 _____mega-ohm
between core 1 to core 3 _____mega-ohm
duration used :
e. High voltage test : Voltage Duration
between core and earth
between individual cores

D. MODE OF MEASUREMENT

The cables shall be measured in rmt and terminations on unit basis.

EARTHING

1.0 EARTHING

The agency shall provide the complete bonding & earthing of the neutral point of power system & non current carrying metal parts of all electrical equipments & apparatus.

Each & every piece of electrical equipments & apparatus shall be connected to the main earth bus by means of branch main connection of earth continuity conductors.

All electrical equipments, except those operating at extra low voltages shall be provided with an earth terminal.

All types of electrodes comprising an earth system shall be connected together with a continuous ring of earth conductor. After installation tests shall be made to ascertain that the earth resistance hereinafter specified is obtained. If the required resistance value can not be obtained , a sufficient number of additional electrodes shall be installed until the resultant resistance not exceeding the specified value can be obtained.

In all cases, the electrodes shall be driven such that the zones of earthing do not overlap.

Each earth electrode shall be connected to its associated earth conductor through a linked connection. The link shall be installed as close to the earth electrodes as possible. Each earth electrodes shall be enclosed together with the link in a reinforced concrete hand hole with slab cover, which shall be set flush with the ground.

A continuous earth ring of GI flat as specified shall be provided in the electrical room and connected to the earth electrodes. The resistance between any point on each earthing system and the earth electrodes shall not exceed 1 ohm. The overall resistance between the earthing installation and the general mass of earth shall be less than 1 ohm.

The system earthing shall be carried as per IS-3043.

All non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits, trunking cables, switch gears, distribution boards, light fitting and all other parts made of metal shall be bounded together & connected by means of specified earthing conductor to an efficient earthing system. All earthing shall be in conformity with Indian Electricity Rules.

EARTHING CONDUCTORS:

Earthing conductors shall be of electrolytic copper / GI & shall be protected against mechanical injury or corrosion. Zinc coating shall be as per latest IS codes.

SIZING OF EARTHING CONDUCTORS:

The cross-sectional area of copper earthing conductor shall not be smaller than the largest current carrying conductor subject to an upper limit of 80 Sqmm. If the area of the largest current carrying conductor or busbars exceeds 160 Sqmm than two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or busbars. All fixture outlet, boxes & junction boxes shall be earthed with multi stranded copper wires.

All three phase switches & distribution boards up to 60 amp. rating shall be earthed with 2 nos. distinct & independent 3 mm dia GI wires. All three phase switches & distribution boards upto 100 amp. rating shall be earthed with 2 nos. distinct & independent 4mm. Dia GI wires. All 200 amp & above switches shall be earthed with minimum of 2 nos. separate & independent 40 mm x 6mm GI strip.

EARTHPIT DETAILS:

Copper/Galvanized / cast iron earth plate of 600x600x3 mm/1200x1200x6 mm in size buried in specifically prepared earth pit of 1.5 meters below ground level with 40 kg charcoal & salt with alternate layers of charcoal & salt with 50mm. dia. GI pipe with funnel with wire mesh for watering & brick masonry block cover, heavy duty CI cover complete as per IS 3043 with necessary length of double GI earth wire of 6 SWG bolted with lug to plate with cadmium

plated GI nut-bolts & covered in 12 mm dia GI pipe 2.5 meters long complete connected to nearest switch gears as directed & duly tested by earth tester.

Pipe electrodes shall be of 3 M long 65mm dia class C GI pipe. The GI pipes shall be provided with holes at regular intervals as per IS 3043.

RESISTANCE TO EARTH

The over all resistance of earthing system shall not exceed 1.0 ohm.

Individual earth stations should not exceed 5 ohms.

Standard earthing to achieve the above parameters shall be done.

26.0 I.S. CODES

Following IS CODES will be applicable for the project.

1) IS : 659 - 1964	:	Safety Code for Air-conditioning.
2) IS : 660 - 1963	:	Safety Code for Mechanical Ref.
3) IS : 5111 - 1969	:	Code of Practice and Measurement Procedure for Testing Refrigerant Compressors.
4) IS : 325 - 1970	:	Specifications for 3 Ph. Induction Motor. Also confirm to IS : 1231 for Foot Mounted & IS : 2223 for flange mounted motors.
5) IS : 2147 - 1962	:	Degree of protection provided by enclosures for low voltage switch and control gears.
6) IS : 3012 - 1965	:	Code of Practice for installation (PART-I) & maintenance of switchgear.
7) IS : 3016 - 1982	:	Code of Practice for Fire precautions in welding and cutting operations.
8) IS : 3615 - 1967	:	Glossary of terms used in Refrigeration and Air-conditioning.

9) **IS STD.FOR INSULATION WORK-**

9.1)	IS : 4671 - 1984	:	Expanded Polystyrene For Thermal insulation purposes
9.2)	IS : 661 - 1974	:	Code of Practice for Thermal Insulation of Cold Storages.
9.3)	IS : 7240 - 1981	:	Code of Practice for Application and finishing of Thermal Insulation
9.4)	IS : 7413 - 1981	:	Code of Practice for Application material at Temp. from –80°C to 40°C. & finishing of Thermal Insulation material at Temp. from 40°C to700°C.
9.5)	IS : 8183 - 1976	:	Specifications for Bonded Mineral Wool.
10)	IS : 1239	:	Pipes up to 150 MM Dia.
11)	IS : 3589	:	Pipes above 200 MM Dia.
12)	IS : 780/ISI	:	Values of PN 1.6 rating Certificate
13)	IS :5312/ISI	:	Check Valves Certificate
14)	IS : 900	:	Installation of motor

15)	IS :4064 & 4047	:	Switch fuse unit
16)	IS : 2516	:	ACB
17)	IS : 3069	:	Glossary of Items symbols & units relating to thermal materials.
18)	IS : 702	:	Industrial bitumen.
19)	IS : 8183	:	Bonded Mineral Wool
20)	IS : 655 – 1963	:	Ducting work.
21)	IS : 277	:	For Sheet galvanizing spec.
22)	IS : 3043 -1963	:	Earthing.
23)	IS : 3043	:	Earth Station.
24)	IS : 732 - 1963	:	Testing of Electrical Installation.
25)	IS : 520	:	Standard for positive displacement Refrigeration, compressor and condensing unit.
26)	IS : 2825	:	Unfired pressure vessels.
27)	IS : 4503	:	Shell and Tube type Heat Exchanger.

27.0 TECHNICAL DATA

WATER CHILLING UNITS
(TO BE FURNISHED ALONG WITH OFFER)

1.0	Overall chilling machine	:
1.1	Dimensions (LxBxH)	:
1.2	Actual Capacity (TR)	:
1.3	Make	:
1.4	Model	:
1.5	Quantity (Nos.)	:
1.6	Overall Weight (shipping / operating)	:
1.7	Type of vibration isolation	:
1.8	No. of compressors per evaporator	:
1.9	No. of refrigerants circuits per evaporator	:
1.10	Overall IKW/TR	:
	IKW/TR as per ARI Standard & as per const. Cond. temp.	
	100%	
	75%	
	50%	
	25%	
	NPLV	
1.11	Total connected load per evaporator (KW)	:
1.12	Overall starting current at panel (A)	:
1.13	Minimum clearance required from adjacent structures – m	:
1.14	Minimum clearance required between two machines – m	:
1.15	Whether any plat form of Pedestal required for installation? If so, furnish details	:
1.16	Noise level at a distance of 1m from the machine at intervals of 1m along the perimeter	:
1.17	Noise level as mentioned above when All the machines are working – db	:
1.18	Finish details i.e., hot dip galvanised, Corrosion resistant etc.	:
1.19	Whether factory fabricated	:
2.0	**Compressor**	**:**
2.1	Actual Capacity (TR)	:
2.2	Saturated Suction Temp. (°C)	:
2.3	Saturated Discharge Temp. (°C)	:
2.4	Refrigerant	:
2.5	Make	:

2.6	Model	:
2.7	Type	:
2.8	Quantity per Evaporator	:
2.9	Unloading Steps	:
2.10	Capacity Control Type	:
2.11	Control Panel Details	:
2.12	Motor KW	:
2.13	Electrical Characteristics	:
2.14	Motor Make	:
2.15	Frame Size	:
2.16	Insulation Class	:
2.17	Protection Class for compressor motor	:
2.18	Type of motor	:
2.19	Full load current – amps.	:
2.20	Starting current – amps	:
2.21	Maximum instantaneous unit current –amps:	

3.0	**Condenser –Water cooled**	**:**
3.1	Make	:
3.2	Model	:
3.3	Capacity	:
3.4	Entering water Temp. (℃)	:
3.5	Leaving water Temp. (℃)	:
3.6	Capacity at design condition	:
3.7	Water quantity (CMH)	:
3.8	Tubes	
	Type	:
	OD	:
	Material	:
	Thickness	:
	No. of tubes	:
3.9	Condensing Temperature	:
3.10	Water Flow Velocity (m/sec)	:
	Pressure drop (mmwc)	:
3.11	Instruments / Controls for water cooled condenser	:
3.12	Drain Connection Size	
3.13	Fouling Factor	:
3.14	Condenser connections	
	Inlet dia	:
	Outlet dia	:
3.15	Material of shell & thickness	:
3.16	Microprocessor panel details	:
3.17	Building management system – Compatibility	: Yes / No
3.18	Compliance with technical specification	: Yes / No
3.19	Catalogues	: Enclosed / Not enclosed

3.20	Spares list for two years operation	: Attached / Not attached
3.21	Maintenance Charges	: Quoted / Not Quoted
3.22	Heat rejection capacity at operation conditions	:
3.23	Whether any sub-cooling circuit provided? If so, furnish details	:
3.24	Test pressure – Kg/cm^2	:
4.0	**Evaporator**	**:**
4.1	Make	:
4.2	Model	:
4.3	Entering Water Temp. (°C)	:
4.4	Leaving Water Temp. (°C)	:
4.5	Water Flow Rate (CMH)	:
4.6	Capacity at design conditions	:
4.7	No.of passes	:
4.8	Tubes	
	Type	:
	OD	:
	Material	:
	Thickness	:
	No. of tubes	:
4.9	No.of refrigerant circuits	:
4.10	Water Flow Velocity (m/sec)	:
	Pressure drop (mm wc)	:
	Shell dia and length M x M	
4.12	Insulation details	:
4.13	Drain Connection Size	:
4.14	Fouling Factor	:
4.15	Evaporator connections	
	Inlet dia	:
	Outlet dia	:
4.16	Material of shell & thickness	:
4.17	Water side surface area (sq.m)	:
4.18	Ref. Side surface area – sq.m	:
5.0	Microprocessor panel details	:
6.0	Building management system – Compatibility	: Yes / No
7.0	Compliance with technical specification	: Yes / No
7.1	Catalogues	: Enclosed / Not enclosed
7.2	Spares list for two years operation	: Attached / Not attached
7.3	Maintenance Charges	: Quoted / Not Quoted
7.4	Test Pressure	: Kg./Sqcm.

Starter for Compressor Motor
Manufacturer
Type of Starter
Voltage of Holding Coil
Specific details of Starter

TECHNICAL DATA SHEET
PUMP
(TO BE FURNISHED ALONG WITH OFFER)

Note : All details to be submitted for each of the Pumps

	Primary Chilled Water Pump	**Secondary Chilled Water Pump**	**Condenser Pump**
1.0 **Design Features** :			
1.1 Pump Designation :			
1.2 Minimum Design Capacity (m^3/hr):			
1.3 Head (m) :			
1.4 Location :			
1.5 Maximum rated speed at 50 Hz :			
1.6 Liquid Handled :			
1.7 Quantity Required :			
2.0 Features of Construction			
2.1 Type of Pump :			
2.2 Impeller :			
2.3 Shaft :			
2.4 Drive Transmission :			
2.5 Seal :			
2.6 Prime Mover :			
2.7 Variable Frequency Drive :			

3.0 Materials of Construction 3.1 Impeller : 3.2 Casing : 3.3 Shaft : 3.4 Shaft Sleeve : 3.5 Impeller ring : 3.6 Casing Ring : 3.7 Stuffing Box Packing : 3.8 Base plate : **4.0 Accessories** 4.1 Companion Flanges : 4.2 Foundation bolts : 4.3 Base Plate :			

TECHNICAL DATA SHEET

AIR HANDLING UNITS
(TO BE FURNISHED ALONG WITH OFFER)

Note : All details to be submitted for each of the AHU's

General

1.1	Manufacturer	:
1.2	Make	:
1.3	Model	:
1.4	Quantity	:
1.5	Construction type	:
1.6	Insulation material/thickness-outside / inside:	
1.7	Weight – Static weight	:
	Operating weight	:
1.8	AHU casing material thickness	:

2.0 Fan Section

2.1	Fan make	:
2.2	Model	:
2.3	Type	:
2.4	Capacity (CMH)	:
2.5	Static pressure (mm wc)	:
2.6	Total pressure (mm wc)	:
2.7	Outlet velocity (m/sec)	:
2.8	Speed (RPM)	:
2.9	Outlet size (mm)	:
2.10	BKW	:
2.11	Motor I KW	:
2.12	Motor capacity	:
2.13	Motor make	:
	Type	:
2.14	Electrical characteristics	:
2.15	Vibration isolation type	:
2.16	Maintenance for bottom (ceiling suspended units):	
2.17	Fan impeller material/thickness	:
2.18	Fan casing material/thickness	:
2.19	Shaft material /dia	:
2.20	Drive	:
2.21	Belt guard provided	: Yes / No

3.0 Coil Section

3.1	Make	:
3.2	Model	:
3.3	Heat transfer capacity (TR)	:
3.4	Entering Chilled Water Temp. (deg.C)	:

3.5	Leaving Chilled Water Temp. (deg.C)	:
3.6	Water Flow Rate (Usgpm)	:
3.7	Chilled water pipe connection sizes(mm)	:
3.8	No.of Rows	:
3.9	Pressure drop on water side(mm wc)	:
3.10	No. of circuits	:
3.11	Coil	
	Material	:
	Thickness	:
	OD	:
3.12	Fins	
	Material	:
	Thickness	:
	Spacing	:
	Type	:
3.13	Coil dimensions / Sections	:
3.14	Drain pan material / Thk.	:
3.15	Face velocity (m/sec)	:
3.16	Bypass Factor	:
3.17	Face area	:
3.18	Coil entering air conditions	:
3.19	Coil leaving air conditions	:
3.20	Pressure drop air side	:
3.21	No. of circuits	:
3.22	Heat transfer area air side(sq.m)	:
	water side (sq.m)	:
3.23	Heater Capacity, configuration, material	:
3.24	Heater cable size, material, type	:

4.0 Filter Section

5.0 Pre filter

5.1	Make	:
5.2	Model	:
5.3	Quantity	:
5.4	Size(mm X mm)	:
5.5	Capacity through filter(cmh)	:
5.6	Face velocity(m/sec.)	:
5.7	Dust holding capacity	:

5.8 Pressure drop (clean) mm wc :

(dirty) mm wc :

5.9 Efficiency according to AFI :

5.10 Filter material :

5.11 Filter frame material :

6.0 Other Details

6.1 Fan is dynamically balanced? : Yes / No

6.2 Rating chart for fan, cooling coil and Filter enclosed : Yes / No

6.3 Catalogues : Yes / No

6.4 Vibration isolation arrangement :

6.5 Noise level (within one metre distance Radius) :

6.6 Compliance to technical specification :

6.7 Spares list for two years operation :

6.8 Maintenance Charges :

TECHNICAL DATA SHEET

FAN COIL UNITS
(TO BE FURNISHED ALONG WITH OFFER)

Note : All details to be submitted for each of the FCU's

General

1.1	Manufacturer	:
1.2	Capacity	:
1.3	Air Quantity – CFM	:
1.4	Type of Finish	:
1.4	Casing:	
	Material	:
	Thickness	:
1.5	Interior Chasis	:
1.6	Drain Pan material & thickness	:
1.7	Drain Pan Insulation material, thickness and density	:
1.8	Coil	:
	Coil End Plate material	:
	Coil End Plate thickness	:
1.9	Tubes	
	Material	:
	OD	:
	Thickness	:
	Rows	:
1.10	Fins	
	Material	:
	Thickness	:
	Fin Spacing per inch	:
1.11	Coil Face area (Sqm.)	:
1.12	Type of Filter	:
	Filter Thickness, mm	:
2.0	FAN	:
2.1	Type	:
2.2	Make	:
2.3	Material	:
2.4	Thickness	:
2.5	SP – mm WG	:
2.6	Dimensions of FCU	:
	Length – mm	:
	Width – mm	:
	Height – mm	:
2.7	Dimensions of Outlet – W x H	:
	Width – mm	:
	Height – mm	:
2.8	Flange width – mm	:

2.9	Motor make	:
2.10	Motor Rating (HP)	:
2.11	Electrical characteristics	:
2.12	Motor Speed (RPM)	:
2.13	No of Speeds	:
2.14	Catalogues	:
2.15	Details of FCU controls	:

TECHNICAL DATA SHEET FOR
CENTRIFUGAL FANS
(TO BE FILLED BY THE VENDOR AND TO BE SUBMITTED ALONG WITH THEIR OFFER)

A. **GENERAL**

1. Manufacturer :
2. Model No. :
3. Type of fan : Centrifugal SISW / DIDW
4 Impeller type :
5. Quantity offered :
6. Fan Discharge arrangement :
7. Manufacturing standard :
8 Type of drive : Direct/Belt/Coupling
9 Impeller Diameter mm :
10 Service :
11 Dimensional details with motor/acc :

B. CENTRIFUGAL FAN DATA

1. Capacity at rated speed (CMH) :
2. Static pressure at rated capacity (mmwg) :
3. Velocity pressure at rated capacity (mm wg) :
4. Total pressure at rated capacity (mmwg) :
5. Fan speed (rpm) :
6. Air velocity at fan discharge (m/s) :
7. Class of construction (as per AMCA):
8. Fan arrangement (as per AMCA) : Arg.3/Arg.4/Arg9
9. Impeller arrangement : Over hung/simply supported
10. Shaft power at rated speed (kW) :
11. Limit load power at rated speed (kW):
12. Motor (kW / pole) :
13. Static efficiency (%) :
14. Total efficiency (%) :
15. Noise level at 1m distance (db A) :
16. GD^2 value (kgm^2) :
17. Starting current :
18. Tip speed (m/s) :
19. Full load torque (kgm) :
20. Starting torque (kgm) :
21. Fan Critical speed (rpm) :
20. Impeller balancing standard :

21.	Fan outlet size	:
22.	Fan outlet damper size / type	:
23.	Spark proof construction	:
24.	Type of starter recommended	:
25.	Painting	:
26.	Static weight (Kg)	:
27.	Dynamic weight (Kg)	:
28.	Motor weight (Kg)	:
29.	Fan characteristic curves	: Enclosed / Not Enclosed
30.	Foundation recommended	:

C. MATERIAL OF CONSTRUCTION / THICKNESS

1.	Casing – side plate/scroll	:
2.	Impeller – Back plate/blade/shroud	:
3.	Impeller – Hub material / dia	:
4.	Shaft material / dia	:
5.	Inlet cone or bell mouth cone	:
6.	Flexible connection	:
7.	Bearing type / make	: :

D. ACCESSORIES TO BE PROVIDED

1.	Common base frame with mounting skid	:
2.	Anchore Bolts/Foundation Bolts	:
3.	Vibration isolators	:
4.	Flexible coupling	:
5.	Coupling cover	:
6.	Drive pulleys	:
7.	(a) V-belt guard	:
	(b) V-belt	:
8.	Lifting lugs	:
9.	Drain valve/plug	:
10.	Inlet screen	:
11.	Shaft guard	:
12.	Slide rails for motor	:
13.	Outlet Damper (Manual)	:
14.	Variable Inlet Vanes (VIV) (Manual)	:
15.	Vibration Isolators	:

TECHNICAL DATA SHEET FOR
AXIAL & PROPELLER FANS
(TO BE FILLED BY THE VENDOR AND TO BE SUBMITTED ALONG WITH OFFER)

1. Manufacturer :
2. Model No. / Type :
3. Capacity CMH :
4. Static pressure at rated capacity mmwc :
5 Outlet Velocity m/s :
6. Velocity Pressure mmwc :
7. Total Pressure mmwc :
8. Fan rated speed rpm :
9. Impeller Diameter mm :
10. Class of construction and arrangement (AMCA):
11. Motor Position : (Inside the casing Direct Driven)
12. Shaft Power kW :
13. Limit Load kW :
14. Motor kW/P :
15. Motor Spec : IP55 / Class -F
16. Critical Speed of Fan rpm :
17. Total Efficiency at Rated speed % :
18. Material of Construction :
    a. Casing :
    b. Impeller :
    c. Blades :
    d. Inlet / Outlet cone :
    e. Guide Vane :
19. Type of Fan Drive : Direct
20. Vibration Isolators :
    a. Vibration levels :
    b. Make / Type :
    c. Size & Nos. :
    d. Deflection / Isolation Efficiency :
21. Sound Level @ 1m distance (Tested as per AMCA-300): dBA
22. Weights of :
    a. Fan Kgs :
    b. Motor Kgs :
    c. Accessories Kgs :
    d. Total Operating Weight Kgs :

28.0 LIST OF APPROVED MAKES:

A. Contractor shall use the material of approved make as indicated below unless specified otherwise in BOQ or as approved by the Employer's representative.

B. The Contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, Employer's representative/engineer reserves the right to opt for best preferred listed make.

C. The Contractor shall quote the rate for material and equipment as per the list of approved makes. In the event of the Contractor wants to use alternate makes other than those stipulated for any reason, the Contractor can send a proposal after ensuring that what he proposes at the least meets both the quality, and safety standard of the stipulated makes, and the financial benefit that will accrue to the Employer. He shall also stand full guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the employer, whose decision will be final in the matter.

Details of Materials / Equipment	**Manufacturer's Name**
Water Cooled screw chiller	Climaventa / Carrier / JCI / Trane
Air Cooled Screw Chiller (Total Heat Recovery)	Blue Box / Climaventa / Uniflair
Cooling Tower	Advance / Baltimore / Evapco / Marley/Paharpur/ Mihir
Primary/Condenser Water Pump (End Suction top discharge).	Grundfoss (Denmark) / ITT – Bell & Gossett (USA)
Secondary Variable Speed Pumping System consist following: Adjustable Frequency Drive Automatic AFD Bypass Pump Controller Differential Pressure Sensor/Transmitter	Grundfoss (Denmark) / ITT – Bell & Gossett (USA)
Air Handling Unit & Air Handling Unit Fan Section	Blue Star / Caryaire / ETA / Flaktwood/VTS
Cooling Coil for AHU	Blue Star / Caryaire / ETA / Flaktwood/VTS
Centrifugal Fan	Comfrei (Italy) / Greenheck (USA)/ Kruger (Singapore)/Nicotra(Italy)
Sensible heat recovery wheel	Flaktwoods / Novelaire/DRI/Greenheck
Heat recovery unit Complete with sensible heat recovery wheel	DRI / Flaktwood /Greenheck

Precision unit	Hiross (Italy)/Stultz (Germany) / Uniflair /
Axial Flow Fan	Greenheck (USA)/ Kruger (Singapore) / Nicotra (Italy)
Mixed Flow Fan	Greenheck (USA) / Flaktwood (UK)
Inline/Propeller Fan/Roof extractor Fan	Greenheck (USA)/ Kruger (Singapore) / Nicotra (Italy)
Air washer (Wetting Pad type)	Ambassador / Emerald / Roots Air /Roots Cooling
2 stage evaporative unit	Amax / Ambiator
Dry Scrubber with ESP precipitator	Espair / Rydair / Trion
Fan Coil Unit	ETA / Bluestar
Cassette Units – Chilled water based	Daikin / ETA / Media / Zen / Bluestar
GI Sheet	Jindal / TATA/ Nippon
Factory Made Duct	Rolastar/ Radiant air systems / Techno fabri duct/ Techno Aircon
Grille/diffuser / Volume controller	Caryaire / Ravistar/Airflow
Volume flow limiter	Adalad / Trox
Motorised smoke & Fire Damper – UL listed	Greenheck / Ruskin/ Trox
Fusible link fire damper – UL listed	Greenheck / Ruskin/ Trox
Motorised smoke & fire damper – (Non UL listed)	Ruskin / Systemair / Trox/ Greenheck/ Ravistar
Fusible link fire damper – Non UL listed	Ruskin / Systemair / Trox / Greenheck/ Ravistar
Anchor Fastener	Fischer / Hilti
G I threaded rope	Hi-tech / Rolastar
Wire rope duct supporting arrangement	Gripple
Variable Air Volume Box (Unit)	Titus / Trox/Carryaire
Factory Made Spiral Duct	Atco / Seven Star
Sound Attenuator	Caryaire / Dynacraft / Ravistar / Trox
Hepa filter boxes	Airtech / Dyna
Hepa filters	Airtech / Pyramid / Dyna / AAF
Ultra violet germicidal system	Rusks / Trimed
PIPES & FITTINGS	
M.S. Pipe upto 150 mm Dia.	Jindal Hissar / Tata Steel

MS PIPES 200 mm and above dia factory rolled	HSL / Jindal Hissar / TATA
Pre-insulated pipes (Makes of pipes as mentioned)	Permapipe / Zeco
Butterfly valve	Audco / Advance
Actuator for Butterfly Valve with	Belimo / Honeywell / Invensys / Itork / Johnson Control / Sauter / Schneider / Siemens
Balancing valve (Manual)	Advance Valve / Danfoss / Honeywell / Navtech / TA Digital
Balancing Valve cum flow control (Pressure independent dynamic) Automatic	Danfoss / Flowcon / TA Auto Flow
Ball valve	Rapidcool/Oventrop/Audco/Kirlosker
Check valve	Advance Valve / Honeywell / Kirloskar
Pot / Y Strainer	Emerald / Trishul / Leader / Maharaja casting/ sant
Suction guide strainer	Anergy / Flowcon
Ball valve (Fan Coil Unit)	Cimberio / Emerald / Itap / Kitz / RB
Ball valve with Y-Strainer (Fan Coil Unit)	Cimbers / Emerald / Rapid Control / RB
Closed type expansion tank	Anergy / Bell & Gossett / K D Agency / Spirotech
Air & dirt separator	Spirotech / Spirotherm
Vacuum degasser	Spirotech/ Spirotherm
Pressure Gage	Emrald / Fiebig / H Guru.
Thermometer	Emerald / H Guru / Taylor
Auto Air Vent Valve	Flemco / Itap/ Spirotech
Bellows	Easy flex / Dunlop / Kanwal / Resistoflex
Flexible conn.	Easy flex / Dunlop / Kanwal / Resistoflex
Fire retardant canvass conn.	Arma duct / Climatech
Chemical dosing system	Aqua bid / Chemitrol / Eco / Ion exchange / Nalco/ Spirotech
Online Nonchemical Water treatment system	Scale Guard/ Crystallo/ Scaloid
Fire Wrap/Board/Paint	Birla 3 M / Hilti / Promat

Insulation:

Closed Cell Elastomeric along with adhesive Cross link polyethylene foam with adhesive	Armacell /Aeroflex
Protective Coating over Closed Cell	Armacell

Elastomeric – Fibreglass Woven Cloth	Paramount / UP Twiga
UV Protective coating Polybond	Armacell Armachek / Amicol / Paramount /
Fire Sealant	Birla 3 M / Hilti / Promat
Controls	
VFD	ABB / Danfoss / Siemens
Two way valve for AHU	Belimo / Danfoss / Oventrop / Honeywell / Invensys / Johnson Control / Sauter / Schneider / Siemens
Two way motorised diverting Valve for FCU	Danfoss / Honeywell / Johnson Control / Sauter / Schneider / Siemens / Yamataki
Proportionate Room Thermostat with Digital	Honeywell / Johnson Control / Sauter / Temperature/ Indication for FCU Schneider / Siemens / Yamataki
Humidistat	Honeywell / Invensys / Johnson Control / Sauter / Siemens
Dial Thermometer Capillary Type.	Penn / Tadington
Rigid PVC LHSFT Conduit and accessories for conduit	1.6-1.8 mm wall thickness ISI & FIA approved & manufactured from virgin material. Precision plastic industries, Polycab, AKG, BEC
GI Conduit	BEC/ AKG
Copper Conductor HFLS/ZHFR Stranded copper wire	Finolex, R R Kabel, Havells, Polycab, Bonton, L&T
HRC Fuses	Merlin Gerin – multi 9, Legrand, Hager, Seimens, GE, C&S, ABB
MCBs	Merlin Gerin – multi 9, Legrand, Hager, Seimens-Betagard, ABB, GE
PVC tape	Steel grip
Compound	Shalimar No. 6.
1100 V LT FRLS XLPE/PVC cables	Finolex, CCI, Gloster, Havells, Polycab, RPG, Universal
MICC Cable	Tyco (Pyrotenax)

Glands (Double Compression type)	Dowells, Comet, Siemens, Peeco
Cable Lugs	Dowells, 3-D
Connectors	Connectwell, Elmex.
Button holder, Angle holder, ceiling rose	Anchor
Anti vibration Ball	Aluminium (sample to be approved)
ELCB/ ELMCB	Merlin Gerin – multi 9, Legrand, Hager, Siemens-Betagard
A.C.B. Draw out type (LT):	Schneider Master Pact NW range with Micrologic 6.0 A releases and equivalent of ABB E-Max PR122 Release/ L&T U power with UWMT x 3.5 releases / Siemens 3WL with ETU45B + LSING + current display breaker.
MCCB	Schneider Compact range NSX with Micrologic 2.0/6.0, ABB T-Max Series with Microprocessor release PR 221/222, L & T Dsine range – RC 10/20 / Siemens 3VL series with ETU 20/42.
Telephone tag block	Krone
Capacitor	Epcos, L&T, Schneider Mehar, Siemens, ABB ,Ducati (imported), Datar, Shreem,
Relay	Alstom, ABB, L&T, Siemens, Epcos, Enercon, Ducati (Imported)
Meter (Digital)	Conserv, SEMS, Elmeasure, Enercon, AE, Securemeco, Allan-bradley, L&T, Motwane, Ducati (Imported)
Heavy pipes should be 6 kg/sq.cm.	Jyoti , Jindal ,Tata
Ceiling Fans	Crompton – High Speed, Orient, Khaitan, Alstom

Exhaust Fan with gravity louvers	Usha Lexus or equi of crompton / orient, Industrial- Almonard / GEC
Cable Tray –	Steelways, Bharati, M.M. Engg, Asian ancillaries, Dolphin, MEM
Steel Wire Rein Forced PVC Flexible Hose	Flaxi - Hose
Rubber Mat	Jyoti
GI / AL Floor raceways and floor junction boxes	MK, Legrand, L.K., Steelways, Bharati, Schneider
Panel vendors –	Siemens, Schneider, ABB, Tricolote, Adlec, Advance
ATS switches	ASCO (Series 7000/300), GE, Cummins, Socomec
Battery (Maintenance free VRLA Battery)	HBL Nife, Exide, Standard, Amara Raja, Furakawa, Panasonic, Global Yuasa
Battery Charger	HBL Nife, Voltstat, Amar Raja, AE, Caldyne, BCH

29.0 TESTING & COMMISSIONING OF HVAC

GENERAL

DEFINITIONS

Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

CA: Commissioning Authority.

HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

CONTRACTOR'S RESPONSIBILITIES

Perform commissioning tests at the direction of the C.A.

Attend construction phase controls coordination meeting.

Attend testing, adjusting, and balancing review and coordination meeting.

Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the C.A.

Provide information requested by the C.A for final commissioning documentation.

Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

C.A'S RESPONSIBILITIES

Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

Direct commissioning testing.

Verify testing, adjusting, and balancing of Work are complete.

Provide test data, inspection reports, and certificates in Systems Manual.

COMMISSIONING DOCUMENTATION

Provide the following information to the C.A for inclusion in the commissioning plan:

Plan for delivery and review of submittals, systems manuals, and other documents and reports.

Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.

Certificate of readiness, signed by the Contractor, certifying that HVAC&R systems, assemblies, equipment, components, and associated controls are ready for testing.

Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.

Test and inspection reports and certificates.

Corrective action documents.

Verification of testing, adjusting, and balancing reports.

SUBMITTALS

Certificates of readiness.

Certificates of completion of installation, prestart, and startup activities.

EXECUTION

TESTING PREPARATION

Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

Inspect and verify the position of each device and interlock identified on checklists.

Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the C.A.

TESTING AND BALANCING VERIFICATION

Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the C.A.

Notify the C.A at least 15 days in advance of testing and balancing Work, and provide access for the C.A to witness testing and balancing Work.

Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the C.A.

The C.A will notify testing and balancing agency 10 days in advance of the date of field verification. Notice will not include data points to be verified.

The testing and balancing agency shall use the same instruments (by model and serial number) that were used when original data were collected.

Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

Remedy the deficiency and notify the C.A so verification of failed portions can be performed.

GENERAL TESTING REQUIREMENTS

Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the C.A.

Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

The C.A along with the HVAC&R Vendor, testing and balancing agency and HVAC&R Instrumentation and Control agency shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

Tests will be performed using design conditions whenever possible.

Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the C.A and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

The C.A may direct that set points be altered when simulating conditions is not practical.

The C.A may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are as specified in the scope & specification mentioned.Assist the C.A with preparation of testing plans.

Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in piping Sections. HVAC&R Vendor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the C.A. Plan shall include the following:

Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

Description of equipment for flushing operations.
Minimum flushing water velocity.
Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The C.A shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation.

PART 1 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

GENERAL

Section Includes:

Balancing Air Systems:

Constant-volume air systems.

Variable-air-volume systems.

Balancing Hydronic Piping Systems:

Constant-flow hydronic systems.
Variable-flow hydronic systems.

EXECUTION

EXAMINATION

Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

Examine the approved submittals for HVAC systems and equipment.

Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

Examine equipment performance data including fan and pump curves.

Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

Examine test reports specified in individual system and equipment Sections.

Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

Examine heat-transfer coils for correct piping connections and for clean and straight fins.

Examine system pumps to ensure absence of entrained air in the suction piping.

Examine operating safety interlocks and controls on HVAC equipment.

Report deficiencies discovered before and during performance procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

PREPARATION

Prepare a plan that includes strategies and step-by-step procedures.

Complete system-readiness checks and prepare reports. Verify the following:

Permanent electrical-power wiring is complete.
Hydronic systems are filled, clean, and free of air.
Automatic temperature-control systems are operational.
Equipment and duct access doors are securely closed.
Balance, smoke, and fire dampers are open.
Isolating and balancing valves are open and control valves are operational.
Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
Windows and doors can be closed so indicated conditions for system operations can be met.

GENERAL PROCEDURES FOR TESTING AND BALANCING

Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111,NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems & SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing

Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for Testing procedures.

After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Insulation procedure laid down in the specifications.

Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

Take and report testing and balancing measurements in **metric (SI)**] units.

GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

Prepare schematic diagrams of systems' "as-built" duct layouts.

For variable-air-volume systems, develop a plan to simulate diversity.

Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

Verify that motor starters are equipped with properly sized thermal protection.

Check dampers for proper position to achieve desired airflow path.

Check for airflow blockages.

Check condensate drains for proper connections and functioning.

Check for proper sealing of air-handling-unit components.

Verify that air duct system is sealed as specified.

PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

Measure total airflow.

Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

Measure fan static pressures as follows to determine actual static pressure:

Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
Measure static pressure directly at the fan outlet or through the flexible connection.
Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

Report the cleanliness status of filters and the time static pressures are measured.

Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions. First two subparagraphs below may require changes to installed systems or equipment; these changes may require a contract modification.

Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
Obtain approval from **Construction Manager or Commissioning Authority** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements as specified in Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

Adjust volume dampers for main duct, sub main ducts, and major branch ducts to indicated airflows within specified tolerances.

Measure airflow of sub main and branch ducts.

Where sufficient space in sub main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
Remeasure each sub main and branch duct after all have been adjusted. Continue to adjust sub main and branch ducts to indicated airflows within specified tolerances.

Measure air outlets and inlets without making adjustments.

Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
Adjust patterns of adjustable outlets for proper distribution without drafts.

PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
Measure total system airflow. Adjust to within indicated airflow.
Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
Record final fan-performance data.

Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

Balance variable-air-volume systems the same as described for constant-volume air systems.
Set terminal units and supply fan at full-airflow condition.
Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
Readjust fan airflow for final maximum readings.
Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.

Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
Set terminal units at full-airflow condition.
Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
Adjust terminal units for minimum airflow.
Measure static pressure at the sensor.
Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

Prepare schematic diagrams of systems' "as-built" piping layouts.

Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

Open all manual valves for maximum flow.
Check liquid level in expansion tank.
Check makeup water-station pressure gage for adequate pressure for highest vent.
Check flow-control valves for specified sequence of operation, and set at indicated flow.
Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

Set system controls so automatic valves are wide open to heat exchangers.
Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
Check air vents for a forceful liquid flow exiting from vents when manually operated.

PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

If impeller sizes must be adjusted to achieve pump performance, obtain approval from **Construction Manager & Commissioning Authority** and comply with requirements.

Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

Monitor motor performance during procedures and do not operate motors in overload conditions.

Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
Report flow rates that are not within plus or minus 10 percent of design.

Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

Set calibrated balancing valves, if installed, at calculated presettings.

Measure flow at all stations and adjust, where necessary, to obtain first balance.

Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

Determine the balancing station with the highest percentage over indicated flow.
Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
Record settings and mark balancing devices.

Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

Check settings and operation of each safety valve. Record settings.

PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

PROCEDURES FOR MOTORS

Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

Manufacturer's name, model number, and serial number.
Motor horsepower rating.
Motor rpm.
Efficiency rating.
Nameplate and measured voltage, each phase.
Nameplate and measured amperage, each phase.
Starter thermal-protection-element rating.

Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

PROCEDURES FOR CHILLERS

Balance water flow through each evaporator **and condenser t**o within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
Capacity: Calculate in tons of cooling.
For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

PROCEDURES FOR COOLING TOWERS

Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

Measure condenser-water flow to each cell of the cooling tower.

Measure entering- and leaving-water temperatures.
Measure wet- and dry-bulb temperatures of entering air.
Measure wet- and dry-bulb temperatures of leaving air.
Measure condenser-water flow rate recirculating through the cooling tower.
Measure cooling-tower spray pump discharge pressure.
Adjust water level and feed rate of makeup water system.
Measure flow through bypass.

PROCEDURES FOR COOLING/HEATING COILS

Measure, adjust, and record the following data for each water coil:

Entering- and leaving-water temperature.
Water flow rate.
Water pressure drop.
Dry-bulb temperature of entering and leaving air.
Wet-bulb temperature of entering and leaving air for cooling coils.
Airflow.
Air pressure drop.

REPORTING

Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

Status Reports: Prepare **weekly** progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

FINAL REPORT

General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
Include a list of instruments used for procedures, along with proof of calibration.

Final Report Contents: In addition to certified field-report data, include the following:

Pump curves.
Fan curves.
Manufacturers' test data.
Field test reports prepared by system and equipment installers.
Other information relative to equipment performance; do not include Shop Drawings and product data.

General Report Data: In addition to form titles and entries, include the following data:

Title page.
Name and address of the TAB contractor.
Project name.
Project location.
Architect's name and address.
Engineer's name and address.
Contractor's name and address.
Report date.
Signature of Testing Authority's supervisor who certifies the report.
Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
Summary of contents including the following:

- Indicated versus final performance.
- Notable characteristics of systems.
- Description of system operation sequence if it varies from the Contract Documents.

Nomenclature sheets for each item of equipment.
Data for terminal units, including manufacturer's name, type, size, and fittings.
Notes to explain why certain final data in the body of reports vary from indicated values.
Test conditions for fans and pump performance forms including the following:

- Settings for outdoor-, return-, and exhaust-air dampers.
- Conditions of filters.
- Cooling coil, wet- and dry-bulb conditions.
- Face and bypass damper settings at coils.
- Fan drive settings including settings and percentage of maximum pitch diameter.
- Inlet vane settings for variable-air-volume systems.
- Settings for supply-air, static-pressure controller.
- Other system operating conditions that affect performance.

System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

Quantities of outdoor, supply, return, and exhaust airflows.
Water and steam flow rates.
Duct, outlet, and inlet sizes.
Pipe and valve sizes and locations.
Terminal units.
Balancing stations.
Position of balancing devices.

30.0 MAINTENANCE AND COMPREHENSIVE AMC (CHILLERS BY OEM ONLY)

PREMISES: - Sophisticated hospital building consisting of

1. Academic block
2. Clinical block
3. Vivarium block

Scope: Maintenance will cover Comprehensive AMC (CAMC) of all the items. Any material/item required during this 5 years CAMC will be made available by contractor at their own cost and Nothing Extra will be payable .

HVAC EQUIPMENT

1. For air-conditioning as mentioned in tender BOQ.
2. Basement ventilation equipments and ancillaries as mentioned in tender BOQ.
3. Pressurization equipment and ancillaries as mentioned in tender BOQ.
4. Smoke evacuation equipments and ancillaries as mentioned in tender BOQ.

1) Daily Routine Preventive/Scheduled Maintenance of HVAC system on 24 X 365 day basis:
   a) Day-to-day routine maintenance of logbook folders thru IBMS & maintain all data in hard disk.
   b) Daily check list submitted in the Engineering Office.
   c) Cleaning of drain piping external to the equipment
   d) Cleaning the cooling tower on a routine basis.
   e) Routine check and operation of chemical dozing system. Regular cleaning of air & mud separator.
   f) Tightening of all electrical contacts.
   g) Recording of Temperature, Humidity and Fresh Air in different areas of the Institute and adjusting thereof, if required.
   h) Chilled Water Delta T (Δ T) and Condenser Water Delta T (Δ T) to be maintained within permissible limits as per OEM manual, on daily basis.
   i) Checking the Operation of VFDs.
   j) Ensuring proper and effective air conditioning in different areas of the Institute as per the design parameters or on the instructions issued by Engineer in charge HVAC.
   k) Ensuring serviceability of UV tubes in AHUs.
   l) Checking of all the test parameter of chiller plants and managing them in a safe value.
   m) Checking of cooling towers and maintenance of the same.
   n) All VFDs to be kept in working conditions to ensure effective energy saving.
2) Routine checking and general servicing the said HVAC system, which shall include.-
   a) Checking the refrigeration system
   b) Checking of Electrical Panel

c) Checking the motors and starters

d) Checking the operating controls.

e) Reporting the condition of the HVAC equipments to the plant-in-charge of the ILBS in writing and causes for such damage and carrying out all maintenance that may be required.

3. Cleaning of filters, strainer routine cleaning of evaporator coils if required for trouble free operation.
4. Routine cleaning & maintaining of all equipment necessary for trouble free operation.
5. Routine checking condition and settings of panel controls, operating controls, safety controls to ensure optimum performance and reliability.
6. Routine checking of all electrical controls and components (switches, timer, relays, starters etc.) for all utility equipment electrical panel.
7. Routine checking & cleaning of bearings of all motors and pumps.
8. Checking alignment of all equipment, operation of control devices, valve stem, etc. and cleaning and lubricating the same.
9. Routine checking, cleaning of sensors, controllers, DDC panel /controllers.
10. Routine checking of PC workstation, system controller and controller panels, pointers.
11. Routine checking, rectification of communication cables, internal cabling, terminations etc.
12. Cleaning of cooling towers, as required for trouble free operation.
13. Routine checking and maintenance of electrical installation like cabling, dressing of lugs, switchboards, isolators, panels, fuses and associated ammeters/voltmeters as required.
14. **Attend any break down in any installed utility equipment for trouble free operation along with any required spares & consumable.**

ROUTINE MAINTENANCE

WATER SCREW CHILLERS, MULTI PURPOSE CHILLERS, & AIR-CONDITIONING SYSTEM

A) DAILY

1. Checking of water level in cooling water & chilled water system.
2. Start/stop of chilled & cooling water pumps, cooling tower and Ventilation units (Fresh Air & Exhaust Air).
3. Opening/closing of isolation valves on machine for CHW/CW.
4. Starting of the m/c after ensuring rated parameters (pressure drops).
5. Start/stop of AHU, FCU, VAV boxes, UV system.
6. Logging of data as per log sheet
7. Attending day to day operational problems.
8. Start/stop of machines as required.
9. Check incoming supply voltage and voltage between 2 phases.
10. Attending routine problems on machine.
11. Shutting of the valves of AHU & FCU if required.
12. Check refrigerant level, leak test with electronic leak detector. If abnormal, trace and rectify as necessary, Inform department in writing on the rectification.
13. Inspect level and condition of oil. If abnormal, trace fault and rectify as necessary. Inform department in writing on the rectification.
14. Check the liquid line side glasses for proper flow.

15. Check all operating pressure and temperature.

16. Inspect and adjust if required all operating safety controls.

17. Check capacity control adjust if necessary.

18. Lubricate vane/linkage/bearings.

19. Visually inspect machine and associated component and listen for unusual sound and noise for evidence of unusual conditions.

20. Check lock bolts and chiller spring mount.

21. Review daily operating log maintenance by department's operating personnel.

22. Providing written report to Department, outlining services carried out, adjustment made, arrange with department for shut-down to rectify equipment.

B) <u>Bi-WEEKLY</u>

1. Repeat the parameter as mentioned at 'A'.
2. Checking water quality of makeup water and to be maintained with permissible as per OEM manual.
3. Checking of 2-way control valve function related to temperature.

C) <u>MONTHLY</u>

1. Repeat the parameter as mentioned at 'A' & 'B'.
2. Checking of all points & joints visually for any leakage and check of oil level.
3. Checking of all interlock of chiller with pumps & cooling tower.

D) <u>HALF YEARLY</u>

1. Repeat the parameter as mentioned at 'A' & 'B'& 'C'.
2. De-scaling of the condenser as and when required.
3. Replacement of all AHU , FCU, Air washer, Filter's (pre filters , Microbe , Hepa) pressure drop as per OEM manual.
4. Clean and adjust all switch gear, contactors, relays, single phase preventer, TPN and associated electrical equipment at intervals not exceeding six months.
5. Check and prove operation of thermal over load and protection devices.
6. Check and ensure tightness of all equipments fastenings and cable terminations within switch boards.
7. Vacuum clean all switch board cubical.
8. Check all piping system for leaks and repair these where they have occurred.
9. Check for damage & deterioration of insulation or sheathings, rectify as necessary.

BREAK DOWN MAINTENANCE

Any type of break down maintenance inclusive of all required material spares & consumables.

PUMPS

A) DAILY

1. Checking and necessary action for rectification for gland leakages.
2. Checking and necessary action for rectification for abnormal noise.
3. Check the position of inlet and outlet valves for normal operation
4. Check inlet and outlet pressure of the pump.

B) MONTHLY

1. Repeat the parameter as mentioned at 'A'.
2. Checking of current and logging the same.
3. Cleaning of strainers, repair/replace if required.
4. Check and necessary action on condition of love joy coupling.
5. Inspect all water pumps
1. Check all seals, glands and pipelines for leaks and rectify as necessary.
2. Re-pack and adjust pump glands as necessary
3. Check all pump bearings and lubricate with oil or grease as necessary.
4. Check the alignment and condition of all rubber couplings between pumps and drive motors and rectify as necessary.
5. Check all bolts and nuts for tightness and tighten as necessary.
6. Perform all functions for monthly check.
7. Check all flanges for tightness.
8. Check oil temperature control.
9. Check motor terminals.
10. Check connections in starter.

C) HALF YEARLY

1. Repeat the parameter as mentioned at 'A' & 'B'.
2. Dusting of the externals of the pump/motor.
3. Checking of the terminal connections of pump/motor.
4. Checking the pump foundation and advice customer for repairs as and when required.
5. Checking of lubricants, topping up if required.
6. Check ear thing connection of the pump/motor.
7. Change oil in oil sump.
8. Replace filter.

D) YEARLY

1. Repeat the parameter as mentioned at 'A' & 'B' & 'C'.
2. Inspection of impeller, shaft, sleeve and bearing during overhauling. Replace/repair if required, customer to supply for necessary material.
3. Check motors earthing with meggar and connection wiring on each leg.
4. Check motor temperature cut-out, tighten motor terminals.
5. Check starter contacts, arc shield, and transformer.
6. Check dashpot oil, clean dashpot and replace oil when necessary.

7. Test and calibrate overload setting
8. Inspect, calibrate and adjust to original specifications all gauges, safety and operating controls including low temperature and high pressure cutout , oil pressure switch, load limit relay and electrical interlocks.
9. For water cooled condenser systems, inspect condenser tubes for fouling, If fouling exceeds original specifications, the contractor shall carry out cleaning of the tubes at his own expense.

Please note that oil filter gasket nuts & bolts replacement shall deem to be included in the contract.

BREAK DOWN MAINTENANCE

Any type of break down maintenance inclusive of all required material spares & consumables.

COOLING TOWERS

A) <u>DAILY</u>

1. Check the level of water in the cooling water sump.
2. Carry out blow down.
3. Dosing of chemicals as required.
4. Check operation of float valve and quick fill valve.
5. Check the water spray in cooling tower.

B) <u>Bi-WEEKLY</u>

1. Repeat the parameter as mentioned at 'A'.
2. Cleaning of cooling tower sump.
3. Cleaning of strainer, as and when required.

C) <u>MONTHLY</u>

1. Repeat the parameter as mentioned at 'A' & 'B'
2. Check the current of cooling tower fan.
3. Arrest the leakages, if any.
4. Check for thermostat for operation on cooling tower fan cut off.
5. To check the oil level in the gear box, if required.

D) <u>QUARTERLY</u>

1. Repeat the parameter as mentioned at 'A' & 'B'& 'C'
2. Cleaning of fills, if required.
3. Damaged fills to be replaced, if required.
4. Lubrication of bearing, if required.

E) <u>HALF YEARLY</u>

1. Repeat the parameter as mentioned at 'A' & 'B' & 'C'& 'D'
2. Checking of overload relays, cleaning of contactors, if required.
3. Checking and cleaning of nozzles, if required.

4. Checking of blade angle, correct if required.
5. Tightening of hub bolt, if required.
6. Clean and adjust all switch gear, contactors, relays single phase preventer, TPN and associated Electrical equipment at intervals not exceeding six months.
7. Check and prove operation of thermal over load and protection devices.
8. Check and ensure tightness of all equipments fastenings and cable terminations within switch boards.
9. Vacuum clean all switch boards cubical

BREAK DOWN MAINTENANCE

Any type of break down maintenance inclusive of all required material spares & consumables.

VALVES AND PIPING MAINTENANCE

VALVES

1. Quarterly opening and closing.
2. Yearly check for by passing, replace the liner and rectify.
3. Repair of insulation on the valve.
4. Replacing the gasket.
5. Half yearly check up of gland leakages if any.
6. Yearly overhauling and greasing of the valves. Lapping of the valves if, found leaking.

PIPING

1. Yearly inspection of the pipe, siphon, coupling, valves and replace if required.
2. Inspection of pressure gauges, yearly calibration of it, replace if required.
3. Checking of insulation /cladding finish.
4. Check all piping system for leaks and repair these where they have occurred.
5. Check for damage & deterioration of insulation or sheathings, rectify as necessary.

BREAK DOWN MAINTENANCE

Any type of break down maintenance inclusive of all required material spares & consumables.

AIR MOVING EQUIPEMENTS MEANT FOR HVAC, BASEMENT VENTILAITON, PRESSURISATION & SMOKE EVACUATION

A) <u>DAILY</u>

1. Visual inspection of belts, tightness and alignment of belt & pulley.
2. Checking of vibrations and db level
3. Checking of bearing for overhauling.
4. Checking of motor bare bracket bolts.
5. Cleaning of AHU rooms.

6. Checking of AHU for any air/water leakages.
7. Checking serviceability of Split/Window/Cassettes ACs.
8. Checking serviceability of Air Washer, Exhaust Fan and Fresh air Fan.

B) <u>Bi-WEEKLY</u>

1. Repeat the parameter as mentioned at 'A'
2. Opening, checking/ cleaning of strainers and filters, if required.
3. Inspection and alignment of belt, if reqd.
4. Checking of AHU drain.
5. Logging of pressure drops across AHU'S.
6. Cleaning of drain pan.

C) <u>MONTHLY</u>

1. Repeat the parameter as mentioned at 'A' & 'B'
2. Check adjusts as necessary the air of all blowers is in compliances with original specifications.
3. Check the tension of all belt drives and adjust as necessary.
4. Check and lubricate all blowers' bearings.
5. Tighten motor terminals.
6. Check starter contacts, over load relay and single phase preventer.
7. A system check shall be carried out for all Mechanical ventilation (MV), Pressurization and Exhaust system to verify the performance of the systems.
8. Checking of 3 way valve operation.
9. Checking the fresh air damper position.
10. checking of cooling coil condition.
11. Inspect all air handling and fan coil units.
12. Check all air filters and clean or change filters as necessary.
13. Check all water coils, seals and pipelines for leaks and rectify as necessary.
14. Check and re-calibrate modulating valves and controls. Adjust and rectify as necessary to ensure compliance to the original specifications.
15. Purge air from all water coils.
16. Check all fan bearings and lubricate with grease as necessary.
17. Check the tension of all belt drives and adjust as necessary.
18. Check and clean all the condensate pans, trays and drains.
19. Check measure and re-calibrate all sensors if necessary.
21. Check, clean and service smoke detector will trip the AHU's.
22. Check spring vibration isolators for abnormal vibration. Rectify if necessary.
23. Coil to be cleaned by (a) spray of high pressure clean water (not exceeding 30 psi (b) with chemical spray, if necessary.

D) <u>QUARTERLY</u>

1. Repeat the parameter as mentioned at 'A' & 'B' & 'C'

2. Checking of bearing condition, lubrication.
3. AHU filters to be cleaned with blower.

4. Electrical contractor cleaning if worn replace as and when required.
5. Check functioning of relay.

E) HALF YEARLY

1. Repeat the parameter as mentioned at 'A' & 'B' & 'C'& 'D'

2. Cleaning of blower blade.
3. Current to be checked, overload setting to be tested.
4. Greasing of AHU motor.
5. Clean and adjust all switch gear, contactors, relays, single phase preventer, TPN and associated electrical equipment at intervals not exceeding six months.
6. Check and prove operation of thermal over load and protection devices.
7. Check and ensure tightness of all equipments fastenings and cable terminations within switch boards.
8. Vacuum clean all switch board cubical.

F) YEARLY

1. Repeat the parameter as mentioned at 'A' & 'B' & 'C'& 'D'&'E'
2. Check operation of all modulating and fixed dampers controlling air flow through unit. Lubricate all damper bearings and linkages as necessary.
3. Carry out space temperature checks on air conditioned areas with thermo hydrograph. Balance air flow and water flow as necessary the air flow of all fans and AHUs are in compliances with requirement of original specifications. These checks include the calibration of sensors, thermostat, pressure gauges etc.
4. Check noise level of discharge air from diffusers.
5. Replacement of all AHU, FCU, Air washer, Filter's (pre filters, Microbe, Hepa) pressure drop as per OEM manual.
6. Replacement of bearing.
7. Check operation of all modulating and fixed dampers controlling air flow through unit. Lubricate all damper bearings and linkages as necessary.
8. Carry out space temperature checks on air conditioned areas with thermo hydrograph. Balance air flow and water flow as necessary the air flow of all fans and AHUs are in compliances with requirement of original specifications. These checks include the calibration of sensors, thermostat, pressure gauges etc.
9. Check noise level of discharge air from diffusers.
10. Replacement of all AHU, FCU, Air washer, Filter's (pre filters, Microbe, Hepa) pressure drop as per OEM manual
11. Perform all functions for monthly checks.
12. Tighten motor terminals.
13. Check starter contacts.
14. Test and calibrate overload settings.

BREAK DOWN MAINTENANCE

Any type of break down maintenance inclusive of all required material spares & consumables.

FCU / VAV BOXES

A) DAILY

1. Starting of FCU.
2. Air lockage's to be removed.
3. Visual inspection for air flow and operation & VAV BOXES.

B) Bi-WEEKLY

1. Repeat the parameter as mentioned at 'A'
2. Opening, checking/ cleaning of strainers and filters, if required.
3. Checking of air filter and cleaning it.

C) MONTHLY

1. Repeat the parameter as mentioned at 'A' & 'B'
2. Lubricating of bearings.
3. Checking of drain connections.

D) QUARTERLY

1. Repeat the parameter as mentioned at 'A' & 'B' & 'C'
2. Cleaning of blower blade.
3. Checking and cleaning of air filter.
4. Checking of 3-way valve operation.
5. Checking of FCU coil fins, if required.
6. Checking of operation of thermostat control.

E) HALF YEARLY

1. Repeat the parameter as mentioned at 'A' & 'B' & 'C'& 'D'
2. Cleaning of supply and return grills.
3. Checking of temperature conditions.
4. Cleaning of FCU coils if required.

BREAK DOWN MAINTENANCE

Any type of break down maintenance inclusive of all required material spares & consumables.

BUILDING MANGMENT SYSTEM

A) Bi-WEEKLY

1. Routine checking & cleaning of all sensors & DP switches.
2. Routine checking of DDC & controller panel.
3. Routine checking of PC, central station & system controller.
4. Routine checking & rectification of communication cabling.
5. Routine checking of internal wiring & termination.

BREAK DOWN MAINTENANCE

Any type of break down maintenance inclusive of all required material spares & consumables.

Consumable materials :

1. The contractor shall supply the following consumable materials as and when required free of cost.
2. All oils and greases required for lubrication of compressors, fan bearings, motors bearing, blower bearing and other moving parts including on this.
3. All refrigerant required for topping up. Refrigerant loss if due to manufacturing defects are due to negligence shall be made good by the contractor.
4. All consumable filters elements/rolls.
5. All chemicals for the correct chemical treatment or anti-sealant of the cooling tower and chilled water system.
6. All carbon brushes required to replace worn brushes in electric motors.
7. All electric contact points required to replace worn electric contact points in switch gears motors starter gears, electronic control gears and electric relays.
8. All electric fuses require to replace blown fuses.

Expansion tank Annual inspection

1.) Inspect expansion tank, Drain , clean and flush out tanks as necessary

Just before the expiry of the warranty of the contract, the contractor shall carry out a complete system operability test on all the system or subsystems as called for the contract.
The purpose of the test is to verify that the performance of all the system or sub-systems in the contract is in accordance to the specifications.
All test shall be carried out in the presence of the Engineer-in-charge or his representative.
The warranty period is deem to be over if the department or his representative is completely satisfied with the system performance during the test.

Uptime Guarantee

The Contractor is expected to complete the periodic maintenance of the equipments within the time frame as mentioned in OEM's maintenance manuals in order to minimize the non operation period of the equipments. In addition the above, the contractor shall be ready to undertake any kind of defect rectification as and when reported by user department during CONTRACT period. The Contractor/his maintenance staff would be required to attend the defects within stipulated time and inform the client. During the agreement period contractor shall maintain the equipment with 95% uptime calculated on annual basis.

HVAC Comprehensive and maintenance Contract

B.) Monthly Inspection and services:

1.) Check refrigerant level, leak test with electronic leak detector. If abnormal, trace and rectify as necessary, Inform department in writing on the rectification.

2.) Inspect level and condition of oil. If abnormal, trace fault and rectify as necessary. Inform department in writing on the rectification.

3.) Check the liquid line side glasses for proper flow.

4.) Check all operating pressure and temperature.

5.) Inspect and adjust if required all operating safety controls.

6.) Check capacity control adjust if necessary.

7.) Lubricate vane/linkage/bearings.

8.) Visually inspect machine and associated component and listen for unusual sound and noise for evidence of unusual conditions.

9.) Check lock bolts and chiller spring mount.

10.) Review daily operating log maintenance by department's operating personnel.

11.) Providing written report to Department, outlining services carried out, adjustment made, arrange with department for shut-down to rectify equipment.

C.) Annual Inspection Prior to expiry of warranty period :

1.) Perform all functions for monthly check.

2.) Check all flanges for tightness.

3.) Change oil in oil sump.

4.) Replace filter.

5.) Check oil temperature control.

6.) Check motor terminals.

7.) Check connections in starter.

Please note that oil filter gasket replacement shall deem to be included in the contract.

1.) Check motors earthing with meggar and connection wiring on each leg.

2.) Check motor temperature cut-out, tighten motor terminals.

3.) Check starter contacts, arc shield, and transformer.

4.) Check dashpot oil, clean dashpot and replace oil when necessary.

5.) Test and calibrate overload setting

6.) Inspect, calibrate and adjust to original specifications all gauges, safety and operating controls including low temperature and high pressure cutout , oil pressure switch, load limit relay and electrical interlocks.

7.) For water cooled condenser systems, inspect condenser tubes for fouling, If fouling exceeds original specifications, the contractor shall carry out cleaning of the tubes at his own expense.

D.) Monthly Inspection Water pumps prior to expiry of warranty period:

1.) Inspect all water pumps

2.) Check all seals, glands and pipelines for leaks and rectify as necessary.

3.) Re-pack and adjust pump glands as necessary

4.) Check all pump bearings and lubricate with oil or grease as necessary.

5.) Check the alignment and condition of all rubber couplings between pumps and drive motors and rectify as necessary.

6.) Check all bolts and nuts for tightness and tighten as necessary.

E.) Annual Inspection prior to expiry of time period

1. Perform all function for monthly checks
2. Check motors earthing with meggar and connection wiring on each leg.
3. Tighten motor terminals.
4. Check starter contacts
5. Test and calibrate overload setting.

F.) Expansion tank Annual inspection prior to expiry of time period.

1.) Inspect expansion tank, Drain , clean and flush out tanks as necessary .

G.) Air Handling units and fan coil units Monthly Inspection.

2.) Inspect all air handling and fan coil units.

3.) Check all air filters and clean or change filters as necessary.

4.) Check all water coils, seals and pipelines for leaks and rectify as necessary.

5.) Check and re-calibrate modulating valves and controls. Adjust and rectify as necessary to ensure compliance to the original specifications.

6.) Purge air from all water coils.

7.) Check all fan bearings and lubricate with grease as necessary.

8.) Check the tension of all belt drives and adjust as necessary.

9.) Check and clean all the condensate pans, trays and drains.

10.) Check measure and re-calibrate all sensors if necessary .

11.) Check, clean and service smoke detector will trip the AHU's.

12.) Check spring vibration isolators for abnormal vibration. Rectify if necessary.

13.) Coil to be cleaned by (a) spray of high pressure clean water (not exceeding 30 psi (b) with chemical spray, if necessary.

H.) Air handling units and fan coil units Annual Inspection prior to expiry of time period.

11. Perform all functions for monthly checks.

12. Tighten motor terminals.

13. Check starter contacts.

14. Test and calibrate overload settings.

I.) Air Distribution system Monthly and annual Inspection prior to expiry of time period.

1.) Check operation of all modulating and fixed dampers controlling air flow through unit . Lubricate all damper bearings and linkages as necessary.

2.) Carry out space temperature checks on air conditioned areas with thermo hydrograph. Balance air flow and water flow as necessary the air flow of all fans and AHUs are in compliances with requirement of original specifications. These checks include the calibration of sensors, thermostat, pressure gauges etc.

3.) Check noise level of discharge air from diffusers.

4.) Replacement of all AHU , FCU, Air washer, Filter's (pre filters , Microbe , Hepa) pressure drop as per OEM manual

J.) Ventilation monthly check and annual inspection :

2.) Check adjust as necessary the air of all blowers are in compliances with original specifications.

3.) Check the tension of all belt drives and adjust as necessary.

4.) Check and lubricate all blowers bearings.

5.) Tighten motor terminals.

6.) Check starter contacts, over load relay and single phase preventer.

7.) Test and calibrate over load settings.

8.) A system check shall be carried out for all Mechanical ventilation (MV), Pressurization and Exhaust system to verify the performance of the systems.

K.) Switch board Six-Monthly and annual inspection:

1.) Clean and adjust all switch gear, contactors, relays, single phase preventer, TPN and associated electrical equipment at intervals not exceeding six months.

2.) Check and prove operation of thermal over load and protection devices.

3.) Check and ensure tightness of all equipments fastenings and cable terminations within switch boards.

4.) Vacuum clean all switch board cubical.

L.) Piping system monthly and annual inspection :

2.) Check all piping system for leaks and repair these where they have occurred.

3.) Check for damage & deterioration of insulation or sheathings, rectify as necessary.

M.) Consumable materials :

1.) The contractor shall supply the following consumable materials as and when required free of cost.

2.) All oils and greases required for lubrication of compressors, fan bearings, motors bearing, blower bearing and other moving parts including on this.

3.) All refrigerant required for topping up. Refrigerant loss if due to manufacturing defects are due to negligence shall be made good by the contractor.

4.) All consumable filters elements/rolls.

5.) All chemicals for the correct chemical treatment or anti-sealant of the cooling tower and chilled water system.

6.) All carbon brushes required to replace worn brushes in electric motors.

7.) All electric contact points required to replace worn electric contact points in switch gears motors starter gears, electronic control gears and electric relays.

8.) All electric fuses require to replace blown fuses.

Just before the expiry of the warranty of the contract, the contractor shall carry out a complete system operability test on all the system or subsystems as called for the contract.

The purpose of the test is to verify that the performance of all the system or sub-systems in the contract is in accordance to the specifications.
All test shall be carried out in the presence of the Engineer-in-charge or his representative.
The warranty period is deem to be over if the department or his representative is completely satisfied with the system performance during the test.
Delta T

- Delta T to be maintained as per OEM manual.
- Power factor of AC plant panel to be maintained as per OEM manual.
- ACB, MCCB, MCB and TPM to be service as per OEM manual.

It may be noted that ILBS reserves the right to award or not to award CAMC of HVAC System for 5 years . However the same will be binding on the successful tenderer. Further all payments w.r.t CAMC will be handled by ILBS directly and ILBS will enter into agreement for CAMC for 5 years , depending upon the conditions prevailing , for which a separate contract agreement will be made between ILBS and the Sucessful tenderer. Further Clause 30.0 of ITT and Clause 2.2.1.4.2 of NIT Section-2 , of volume-1 will be applicable.

SPECIAL SPECIFICATIONS

FOR

LV SYSTEM WORKS

INDEX

SR. NO.	DESCRIPTION	PAGE NO.
1	ACCESS CONTROL SYSTEM, VISITOR MANAGEMENT SYSTEM	1-22
2	Building Management System	1-59
3	INTEGRATED ADDRESSABLE FIRE DETECTION AND VOICE EVACUATION SYSTEM	1-74
4	IP BASED CCTV SYSTEM	1-45

ACCESS CONTROL SYSTEM,

VEHICLE MANAGEMENT SYSTEM

INTRODUCTION:

The intent of this Specification is to procure a fully operational and integrated Security Systems comprising :-

- Access Management .
- Visitor management.
- Vehicle management .

The Access management System shall be seamlessly integrated with the IBMS system for the purpose of

- Intelligent Airconditioning management,
- Lighting Management (if Required)
- CCTV Systems for Enhanced Security monitoring and Analysis.

and other such features and derived functionalities.

The Bidder shall offer a Access System that shall either share the same database as IBMS / CCTV System, or shall offer a Middleware based solution to achieve the above desired functionality.

The Access Cards to be supplied Shall be Clamshell type HID iClass 2k 13.5 MHz, ISO Thikness, Corporate 1000 format Samrt Cards.

The details of scope are as given below:

1. Supply of Access Control System, Visitor Management System.
2. Installation & configuration of the Server-Client version software as per requirement.
3. Interface development with IBMS System / IP CCTV as Required
4. Long range readers shall be used for Vehicle management.
5. Supply of Components and cabling
6. Installation of cable, conduit & Containment as per the directives in the tender BOQ and Specs.
7. Implementation of the system to the satisfaction of the client, and to meet the intent of the specifications herewith.

GENERAL DESCRIPTION:

1.01 SUMMARY OF WORK

A. This document is intended to specify the requirements for the provision of all equipment, materials, labor, documentation and services necessary to furnish and install a complete and operational Integrated Security Access Control and Alarm Monitoring System. The system shall consist of a fully automated and integrated Security System, including, but not limited to the following functions and capabilities:

1. Integrated Visitor Management System for visitor's database integration, storage and reporting.

2. Direct Data Interface to an IP Video CCTV Subsystem to provide automatic camera call up and presets as well as scene display through the use of a graphical user interface and simple point and click action; as also for event storage with Picture clip for further analysis and reports.

B. The system equipment and installation shall comply with all provisions and requirements of this specification as well as any and all applicable national, state and local codes and standards.

1.03 SYSTEM DESCRIPTION

A. SYSTEM COMPONENTS

The basic components of the Security Access Control and Alarm Monitoring System shall include:

1. Data Management System Complete with Specified Servers and Client hardware and Software all required database management Modules, configuration software, database storage system software and hardware, as well as complete browser based Access Control and Alarm Monitoring software package including a dynamic and interactive graphical user interface.

2. The SACAM **(Integrated Security Access Control and Alarm Monitoring (SACAM))** system shall also support a fully integrated Visitor Management System, CCTV Subsystem Interface, High Integrity Dial-up & GSM-SMS, Intrusion Detection Functionality and other Subsystem functions as defined in the specifications and contract documents. SACAM File Server shall communicate with SACAM Client Workstations over an industry standard Ethernet Local Area Network (LAN).

3. Location of SACAM File Server shall be as specified in contract documents and drawings

4. SACAM Client workstation, color monitor and keyboard for database entry, operator requested reports and alarm/event reporting. Operator interface shall be browser-driven through easy to understand, screens with point and click buttons. SACAM Client Workstations shall communicate with SACAM File Server over an industry standard Ethernet Local Area Network (LAN). Quantity and location of Operator Terminals shall be as specified in contract documents and drawings.

5. Dynamic and Interactive Color Graphics user interface (on IBMS Screen) with full graphic map/floor plan import and display capability. The system shall have the capability to simultaneously display floor plan maps or photos with coded interactive alarm, reader, and camera and relay icons and indications, together with audible alarm, descriptive text and operator instructions. Quantity and location of Color Graphic maps, alarm points and active response workstations shall be as specified by client / consultant.

6. Logging and report printers shall be provided for the specified locations. Printers shall be black and white, Laser printers of a minimum of 18 PPS print speed using standard A4 size tray feed paper. Quantity and location of printers shall be as specified in contract documents and drawings.

7. Networked intelligent controllers (NICs) shall be capable of utilizing both central processing and true distributed processing technology. Local processing shall be based on the full local storage of cardholders, access groups, time zones, input and output information in controller RAM. In the event that database information has not been downloaded, is corrupted or is insufficient to make necessary local transaction decisions, the NIC shall access the SACAM server directly. The SACAM server shall take over the functions of making access decisions, controlling doors, monitoring alarms, activating relays and performing the functions of remote control and time activated actions. This shall continue until such time as the full database of the NIC has been correctly downloaded from the SACAM server. This function shall ensure that during database downloads to the NIC; operation of the field panel would be the same as though a proper download had been completed. In addition, it ensures that in the event of a corruption of the NIC database, all actions which would have been carried out by the NIC in response to transaction requests and alarm or data inputs will still be performed under the control of the SACAM server.

The NIC shall be a microprocessor-based device, which utilizes a dual 16-bit processor and a 32-bit bus structure. The controller shall have a minimum clock speed of 90 MHz, and shall be configured with at least 128 Kbytes of battery backed dynamic RAM.

The controller shall feature a direct LAN/WAN connection to the controller bus structure in addition to an RS-232 and an RS-485 connection, all of which shall be designed for use in communication with the SACAM server. The NIC shall be capable of

supporting up to 2 Readers or 4 Readers, directly connected readers as well as combined reader/keypads.

The NIC shall be capable of dynamically allocating its memory between database information and transaction history, which shall be stored if the controller has lost communication with the SACAM server or if the NIC is operating in a Dial-up mode.

Such transaction history shall be automatically uploaded to the SACAM server once communication has been restored in the event of link failure.

In its maximum configuration, the individual NIC shall be capable of storing up to 5000 cardholders, and its memory utilization shall be such that if storing database information for 2,000 cardholders, it shall also be capable of storing one million transactions.

The NIC shall have an additional RS-485 port for connection to remote alarm monitoring (RIM) and relay output (RRM) modules. RIMs and RRMs shall be capable of connection in a multi-drop configuration up to 4,000 feet from the NIC. Quantity and location of NICs shall be as specified in contract documents and drawings.

8. Card Readers, Keypads and Access Control Cards shall be provided in the encoding technology and quantities specified in the contract documents and drawings. Door contacts switches, request-to-exit devices, electric locks, local alarm horns, status indicators and other devices shall also be provided as shown on Contract Drawings.

B. SYSTEM HARDWARE

1. SACAM PC

The basic minimum Configuration of the Machine shall be as under:

Client Desktop PC for Access / Attendance Access / Visitor Management : Intel Core 2 Duo Processor with minimum 4GB RAM, 500 GB HDD, Graphics Card suitable for system, DVD Combo Drive, 19" Monitor and Keyboard. Complete with Windows XP / Windows 7 license. Note: Access Management Application Software, Visitor Management Application Software shall be Loaded on this PC.	1	Nos
for Access & Attendance management : At BMS Room/Admin	1	Nos
for Application Software for Access Control	1	Nos
for Application Software for Attendance Management.	1	Nos

Each client workstation shall be capable of supporting the Client Software installed on it for Access / Visitor as described above. It should also be capable of running an Alarm Color Graphics software package concurrently with the standard SACAM Operator software package.

The PC shall be supplied with Ethernet Network Interface Card supporting both 10BaseT and 10 base2 topologies. The system shall be capable of running and supporting multiple network protocols such as TCP/IP, IPX/SPX and NetBEUI concurrently utilizing one (1) Network Interface Card without the need to re-boot the file server.

The system shall be capable of supporting up to 32 SACAM Client Workstations and each with one (1) Printer. This is in addition to the SACAM File Server which may also be used as a Workstation.

The system shall be provided with a fixed hard disk drive with a capacity of at least as mentioned above and shall also be provided with a removable disk drive, directly accessible from the on-line system, with a capacity of at least capacity mentioned above for archiving, and archive reporting purposes.

Also Event transaction data copied and archived to the removable drive shall be capable of being accessed directly from the online operational system application program. Any requirement to copy archive data back to the internal fixed hard disk for archive reporting purposes is not acceptable.

The PC shall be capable of accommodating upgrades in color monitor, hard disk drive, RAM and I/O port capacity, without rendering the SACAM File hardware and/or software obsolete.

2. On-Line Event & Report Printers

a. On-line Alarm Reports and Event Transactions shall be printed on the On-Line Events Printer. The printer shall be a Laser printer utilizing tray feed A4 paper and capable of a print speed of at least 18 PPS.

3. Report Printer

Operator requested and specified database reports shall print on a system Report Printer. Each reports printer shall be a standard laser printer.

4. Networked Intelligent Controllers

The manufacture must support a family of Networked Intelligent Controllers, which are completely field upgradeable or by remote access on IP Network without changing the software or effecting any database information. The same shall be true for remote diagnostics purposes, wherein the service provider will render services for monitoring / improvement / up gradation / trouble shooting.

The controller must support INSTANT ACCESS. Instant Access ensures that the full functionality of the current database is available at any field panel location the instant communication is established between file panel and the SACAM server.

The controller must also support Data Guard, which retains the last complete panel database as a default until the update has been confirmed, ensuring the integrity of the database in the field panel. Data corruptions due to bad telephone lines, and hang-ups during downloads are accommodated by DATA GUARD, which ensures that the field panel always has a complete and fully functional database.

The Networked Intelligent Controller shall utilize true distributed processing technology with the capability of local processing based on the local storage of up to 5000 cardholders, all system access groups and time schedules, and input and output information shall be maintained in the controller's RAM memory.

The Intelligent Controller modules shall be available by the manufacturer that supports the monitoring and control of two (2) or four (4) card readers, with or without keypads and Biometric Readers in any types and combinations.

Each controller must also be capable of expansion, by external Remote Input Modules and/or Remote Relay Modules.

Networked Intelligent Controller shall be provided with an Uninterruptible Power Supply. However, The NIC shall be complete with Battery Charger & Battery suitable for 30 minutes of operation incase of a power failure.

Each Networked Intelligent Controller shall utilize on-board self -diagnostic LEDs, and a connection diagram overlay for ease of installation and service.

Each Networked Intelligent Controller shall support On-Board IP Connectivity, RS-232 connections, RS-485 multi-drop, Dial-up or GSM -SMS, Network communication technologies.

Each Networked Intelligent Controller shall be supplied with all specified options available, including an enclosure with an enclosure tamper switch.

The controller should be network intelligent with the following specifications:

No. of readers per Controller (Max.)	2 or 4
No. of door locks / Controller (Max.)	2 or 4
Access decisions shall be made at	each door controller
Communications links	TCP/IP or RS 485
Cable type	CAT 6 or 2 twisted pair cable
Data transfer between each equipment	Encrypted
Error Checking	Parity checking and message
Facility for Local operator terminal / printer	Required
Communication through	Vendor Design
Facility for accepting Fire alarm input as binary input	Required
Facility for opening the all doors and Pedestrian barrier in case of Fire	Required
Minimum card handling capacity in each control Panel	Should be 15000
Minimum No. of Transaction records at each control panel	Should be 10000
Communications Encrypted or Unencrypted	Encrypted
The communications links shall be	on-line at all times
Communications link failure	Shall be monitored & Alarm raised
If data Corrupted or tampered	Shall be monitored & Alarm raised
Minimum number of holidays definable	32
Scheduling in advance of Hardware	One year
Enclosure	Lockable Steel cabinet
Watch dog	Both Hardware & Software
Power Supply	Switch Mode Power Supply (SMPS)
Output relays controllable (remote)	200
Directly addressable from the Cent. Controller.	80

In addition to the capabilities referred to above, each Networked Intelligent Controller shall be capable of reporting to the SACAM file server the following alarm conditions:

- Enclosure Door Tamper
- Primary Power Failure
- Low Battery Conditions
- Loss of Communications
- All Security and Access Control Violations.

Alarm states reported shall be Secure, Alarm, and four Troubles (open, short, ground, circuit fault).

Quantity and location of Networked Intelligent Controllers shall be as specified in contract documents and drawings.

6. Remote Input Module (RIM)

a. The Remote Input Module shall be provided to support additional input points. The Remote Input Module shall support all industry standard 2-state, 4-state and 5-state alarm input devices.

b. Each Remote Input Module shall support sixteen (16) five states supervised input points and two (2) output relays. Each Remote Input Module shall be capable of being powered by a local 12 VDC UPS.

c. Each Remote Input Module shall utilize on-board self-diagnostic LEDs, for power, communication, and individual zone states, industry standard terminal strips and a pop-in/pop-out circuit board.

d. Each remote input module shall be supplied with all specified options available for plug-and-play operation, including an enclosure with an enclosure tamper switch. Quantity and location of remote input modules shall be as specified in contract documents and drawings.

7. Remote Relay Module (RRM)

a. The remote relay module shall be provided to support additional output relays. The Remote Relay Module shall utilize industry standard 12 volts, 4 amps dry contact output relays. Transistor or TTL level output relays, or relays requiring an additional latching or chained relay release to standard electronic door hardware and alarm annunciation devices shall not be permissible.

b. Each Remote Relay Module shall support eight (8) SPDT, eight (8) DPDT output relays, and three unsupervised inputs.

c. Each Remote Relay Module shall be capable of being powered by a local 12 VDC UPS

d. Each Remote Relay Module shall utilize on-board self-diagnostic LEDs, for power, communications, and individual relay status and a pop-in/pop-out circuit board.

e. Each Remote Relay Module shall be supplied with all specified options available for plug-and-play operation, including an enclosure with an enclosure tamper switch. Quantity and location of Remote Relay Modules shall be as specified in contract documents and drawings.

8. Readers

Readers provided shall be HID I class Reader.

Quantity and location of readers shall be as specified in contract documents and drawings.

Long range HID I class Reader shall be used at gate for vehicles .Read range shall be at least 5 mtrs

All readers shall necessarily be UL Listed.

9. Door Contact Switches

a. Recessed Mount (concealed) magnetic contact switches shall be provided to monitor the status of each card reader controller door and auxiliary door as noted on the contract drawings.

b. Such Door contact Switches shall be either built in to the EM Lock (Feedback type EM Lock), or shall be individual equipment as per the directions of the Consultant / Client.

c. Quantity and location of door contact switches shall be as specified in contract documents and drawings.

11. Request-to-Exit Devices

a. Request-to-exit devices shall be provided to allow a person to exit an access controlled door.

[Quantity and location of request-to-exit devices shall be as specified in contract documents and drawings.]

12. Electric Locking Devices

a. Electriconic locking devices shall be provided to lock (secure) and unlock (unsecure) each card reader controlled door and auxiliary door as note in the contract drawings.

b. Electronic Locking Devices must be capable of being activated from either the RRE or the Networked Intelligent Controller.

c. The Electromagnetic Lock should have an holding force of 600lbs with anodized aluminum housing and adjustable mounting bracket. Supply should be 12V or 24 V DC (selectable)

d. Quantity and location of electric locking devices shall be as specified in contract documents and drawings.

ALL EM Locks shall be UL Listed.

C. SYSTEM SOFTWARE

The software system design shall be object oriented, shall support Server- Client Architecture, and shall be a native 32-bit application running under the Windows 2000 operating system. All client workstations and the server(s) shall have full system functionality and shall not be segregated in any way by function, except as defined by the user authentications of sign on and password.

The system shall have a simple, easy to use graphical user interface which is browser based, and all functions shall be accessible by use of either mouse or keyboard. Help text shall be provided for each screen function, and shall be sufficiently interactive that a user may access page help directly and be provided with explicit information relevant to the particular screen being displayed.

The system shall have a distributed architecture; however the central server shall have the capability to make transaction decisions for access requests, alarm handling and output control. The software shall be provided with a high-speed real time functionality, which allows the server to take over the transaction handling function of NICs, which are being downloaded, or whose database is incomplete or corrupted, and thus maintain the fully functional access and security response of the NICs under these circumstances.

It is vitally important that the access and alarm functionality of the system shall in no way be impaired during periods when database information is being downloaded to NICs or other field devices, or when these NICs or other field devices have insufficient information to make necessary transaction decisions. Thus, it is unacceptable for the performance of NICs to be degraded in any way. Access decisions based solely on company codes or facility codes or even a combination of the two are not acceptable.

Functional Features of ACS software:

- The ACS software system shall have the modules that connect the node controllers on **TCP/IP or RS-485**, scans all the units defined for any events/alarms, and downloads any settings configured by the operator.
- The ACS shall be designed and configured in such a way so that single point failure will have no degradation in overall functionality.
- It shall be the responsibility of the installer to ensure that the hardware and software solution using the PC specified meets the standards and performance criteria as set down in this bid.
- The system software architecture shall be designed not only to provide a high speed open architecture platform for individual single server applications, but

also be specifically designed to insure high speed, high integrity partitioning and redundancy for large cardholder database systems.

- The ACS architecture should store its data in MS – SQL Database. It should have 3 tier architecture.
- The system should be centralized system with Client- Server architecture.
- Access Control system software shall, as a minimum, support the following features:

a. Integration with a wide range of data collection devices such as biometric (fingerprint, face recognition, hand geometry, iris scan), smart card (iClass & Mifare), PIN and Proximity.
b. User defined role and operations
c. Minimum 16 time zones with 2 time shots for each time zone intervals
d. Minimum 32 Holidays and should be expandable if require
e. Global and local, hard, soft and timed anti-pass back/anti-tailgate capability.
f. Bulk addition of cards
g. Navigation window to facilitate easily access to employee details, remote controlling of controller operations & operating modes etc.
h. Configurable alarm-to-relay linking downloaded to field controllers for local operation
i. Configurable automatic, time controlled report generation and/or disk backup commands.
j. Communication monitoring
k. Address book of Employees at security station
l. History/audit trail.
m. Ability to respond to access requests/alarm conditions before and during download to DC
n. Automatic card activation and deactivation
o. Global and local alarm masking by operator or cardholder
p. Access activity analysis by card reader
q. English language software, user friendly and menu driven operator screens
r. On screen help and /or manual
s. Support for different category like employee/ contract employee/ visitors etc.
t. Login and authority rights to the software for each operator
u. cardholder fields updation, deletion & addition
v. User defined database fields per card user.
w. Data searching parameters as and where require

x. anti-pass back/anti-tailgate feature definition
y. Access card enable and disable, Expired card deletion
z. Database backup ,restore, export ,import, archival ,validation
aa. Access group definition , assignment, activation, deactivation
bb. It should define different transaction status like access denied, access granted, Egress pressed, invalid enable or expiry date for card user, anti pass back violation etc.
cc. Emergency card definition such that on occurrence of emergency condition like fire when emergency card is shown to any DCs should opened all access door allowing free entry & exit
dd. Acknowledgement card definition such that when this card is shown to DCs after emergency condition should restore back DCs to normal conditions
ee. Windows options like tile horizontal /vertical or cascade open form windows
ff. Generation of various report for Admin evaluation.
gg. Export of report to text, PDF, excel ,CSV format
hh. Should be capable of integrating with following as a part of this Tender , and / Or in Future as per the directive of the Consultant / Client :

- ERP,HR and legacy Systems
- Time attendance system
- Visitor management system
- Vehicle Management Systems
- Asset tracking system
- Canteen management system

The access control system software shall, as a minimum, support the following features:

a. Cardholder records – 5000 expandable up to 50,000 or as per user requirement.
b. Card readers - 256 Minimum
c. Alarm input points – 1,024 minimum
d. Relay outputs - 1,024 minimum
e. Client workstations - 32 minimum
f. Minimum 256 time schedules and multiple Shift Capability.
g. 16 user-defined alarm categories.
h. Local, hard and soft anti-pass back / anti-tailgate Configurable alarm-to-relay linking, downloaded to field controllers for local operation.
i. Configurable automatic time zone controlled commands, downloaded to the field controller for automatic local operation.
j. History/audit trail.
k. Alarm masking by operator

l. Capability to define within the system variable card formats.
m. Optional elevator control functions
n. Capability to support multiple site and facility codes at card readers
o. Capability to support biometric access control and verification readers.

On-Line System Management & Reporting

The system shall maintain, on disk, an Event Transaction Log File, and be capable of Historical Data Reports as well as Cardholder Report Listings in a variety of formats

a. System Event Transaction Log File.

1. The system shall maintain an Event Transaction Log File on hard disk for the recording of all historical event log data.

2. The historical data file shall maintain the most recent 40,000 log file physical records without having to resort to archived media.

3. The system shall warn the user of the need to archive historical data before data is over-written.

4. The system shall provide the utilities by which the historical event log file may be backed up to a removable disk cartridge of not less than 100-Mbyte capacity, which may be accessed on-line, without the need to copy the archived data back to hard disk. The system must be capable of recalling historical events directly from the back up magnetic media without the need to interrupt normal on-line activity of the SACAM system.

B.Historical Reports.

The system shall be capable of producing the following reports, based on logged historical events over a specified date and time period, both individually and in any combination.

1. Report of valid accesses for a selected cardholder, selected card reader, on selected area.

2. Report of rejected access attempts for a selected cardholder, selected card reader, and selected alarm activation's for a selected alarm point, on selected area.

3. Report of alarm acknowledgments for a selected alarm or group of alarms.

4. In addition, the system shall offer the user the option of directing the historical reports to a client workstation color monitor for display or to the report printer.

c. Cardholder Reports.

The system shall be capable of producing lists of selected cardholder data records on a client workstation color monitor and/or a report printer. The system shall allow the user to select sorting by card number, cardholder name or other fields.

1. Standard Cardholder Record Reports may be requested by an operator, with the data records sorted numerically by encoded card number, alphabetically by cardholder name, numerically by employee number, and numerically by the embossed card serial number. Such

listings may also be requested to include only those cardholders who are authorized access to a specified area (list by security area).

2. Special Employee Report Generator reports may be created by the operator to provide cardholder record listings that include only operator specified data fields. Each report may include conditional testing on up to two (2) data fields in order to include data for only those cardholders that comply with those conditions specified. Each report shall be capable of being sorted in alphabetical or numeric order.

1.04 OPERATIONAL OBJECTIVES

A. CARD ACCESS CONTROL

The Security Access Control System shall provide the following card access control operational objectives:

1. Controlled entry, via access card readers, of only authorized personnel to secured areas based on cardholder information entered and stored in the system database.

2. The access request response time from card presentation, database verification, to electric lock unlock shall be no more than one second in normal operating mode on a fully loaded system.

3. All access requests, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with the cardholder number, name, and access point/area where access was attempted or gained.

4. The software package shall provide for Local Anti-Passback, and also provide a facility for "soft" Anti-Pass back (i.e. allowing entry following an Anti-Passback violation but still report and log the violation.) The system shall also be capable of providing timed Local Anti-Passback for security areas

5. The system shall provide for automatic lock/unlock of access-controlled doors on a scheduled basis using time schedule.

6. Each card and cardholder shall be entered into the database prior to their use. Each card can be manually disabled at any time without the requirement to delete the card. Each card can then be subsequently re-enabled at a later time.

7. Card records shall include the entry of activation and deactivation dates to provide for the automatic enabling and expiring of the card record.

8. The operating mode of access controlled doors shall be indicated as locked, unlocked, or controlled. The door status shall be indicated as open or closed.

9. The system shall provide for the monitoring of the reader controlled door position in order to detect and report Door Forced Open and Door Held Open alarm conditions. Door Held Open condition shall be based on a user-adjustable time period. The act of opening the door shall initiate the door timer, and also cause the immediate reset of the door lock.

10. The system shall provide for the designation of certain calendar days to be holidays, with special access privileges and system activity to be specified for those days.

11. The system shall provide the capability to unlock the door and/or mask (shunt) the door alarm, as user-configured, via a request-to-exit door motion sensor device or exit push-button. The capability shall be software programmable to allow selectable exit reporting.

12. All system controlled electric locks shall be capable of being unlocked via a client workstation color monitor/keyboard and request-to-exit devices.

13. The system shall provide for a completely downloaded and distributed database such that access control decision are made locally at the access controller and, in the event of the failure of the host computer or loss of communications to the host computer, the access control system shall continue to operate using full database information for all cardholders including security areas authorizations, time schedules, expiration dates of cards, holidays, etc. At no time after a card has been entered into the database of the file server and validated, shall the system fail to respond to an access request by a valid cardholder. (Restricted subsets of access control privileges and time schedule facilities in the distributed database will not be accepted).

B. <u>ALARM MONITOR POINTS</u>

The Security Access Control System shall provide the following alarm monitoring and reporting functions:

1. All door contacts and request-to-exit devices must be connected in such a manner to provide supervised alarm monitoring. They must be terminated at the remote reader electronics module local to the door, and shall not be required to be routed back to the networked intelligent controller, unless it is more advantageous to do so. The input points used for door contact and request-to-exit device shall be user-configurable.

2. The system shall provide for special purpose alarm monitoring and/or transaction reporting for specific events, such as, but not limited to the following:

a. Duress condition at a card reader

b. Anti-Passback

c. Rejected access request

d. Controller Cabinet Tampered

e. Commercial AC Power Failure

f Controller Communications Failure

j. Low battery at UPS power supply

C. RELAY OUTPUT POINTS

The Security Access Control System shall provide the following relay output control and operational functions:

1. Each security system output point (door lock, gate controller and other associated relay outputs) shall have a user-specified 16 character, minimum, text identifier. Each point shall be software programmable for activation and deactivation.

2. The system shall allow activation and deactivation of output points manually by the operator, automatically by time schedule, automatically by the activation of an alarm point.

D. DATABASE MANAGEMENT

The system shall provide for the following Database Management capabilities:

1. The software shall be capable of providing for the recall of system historical transactions with a minimum of 6,000 transactions recallable by operator command from the main event transaction file on the file server hard disk. Additional events may be recalled directly from an archived history log file on a removable hard disk cartridge.

2. Data searching parameters shall be provided in the SACAM system software. The search capability shall include, but is not limited to the following:

a. Card Number, Serial Number, Employee Number or Name.

b. Card readers.

c. Security Areas.

d. Alarm Points.

e. Alarm Categories.

f. Date and time periods.

3. The software shall provide report creation capabilities which offer search, organize and sorting according to the operator instructions, and have the ability to print, spool, or display a full report at a printer or client workstation.

4. All operator commands and database entry functions shall be Internet Browser driven with plain English text and prompts, and the system shall provide on-screen 'Help' information by one click of a button. It shall also include multi-media help for certain critical functions.

5. All access to the operator system functions shall require the entry of a valid password. A password must be used by the operator, manager, or administrator to access the system,

with each password access authority being completely user-selectable by individual menu selection.

1.05 QUALITY ASSURANCE

A. TESTS

1. After installation, and before termination, all wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields. The Security Contractor shall maintain a complete log of all such quality assurance tests and make them available for inspection by the OWNER at any time during the construction phase. At the completion of the installation all test results shall become part of the maintenance documentation.

B. INSPECTION

1. The Security Contractor shall carry out the inspection requirements of the contract and shall provide the OWNER with documentation to the effect that off-site work is being properly fabricated, and in accordance with the contract documents.

2. The Security Contractor shall notify the owner sufficiently in advance of the time when quality control tests are to be performed so that the OWNER or their designee may witness such tests, if desired. The presence or absence of the OWNER from these tests shall not relieve the Security Contractor from completing the tests in accordance with the contract documents. Security Contractors QA documentation and practices shall be subject to an Engineer's inspection at any time.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Security Contractor shall provide the latest product model and software version available from each manufacturer at the time of installation. No "beta version" or "test software" products will be accepted. All proposed and provided equipment and/or products shall be from the specified and approved manufacturers only, unless previously approved by the Consultant and/or OWNER.

2.02 MATERIALS

A. All products and materials are to be new and free of defects, damage and corrosion. All materials shall be in compliance to all applicable codes and designed specifically for the function intended.

B. Wire and cable - All wiring and cabling shall be per the manufacturers' recommendations. Unauthorized deviations thereof may result in the voiding of the manufacturer's warranty.

2.03 WARRANTY

A. All products and materials must include a manufacturer's one (1) year warranty. The warranty shall include material and labor to repair faulty equipment.

VISITOR MANAGEMENT SYSTEM : -

A Visitor Management System Shall be Deployed for the purpose of ensuring a better visit Experience for the visitors to the ILBS Premises.

The WorkFLow Shall be as under :

- The Visitors shall seek a Prior Appointment from ILBS Employee to be visited.
- ILBS Authorised Employee shall, through a Web Browser interface intimate the system of a impending appointment with details of the Visitor, time and date of the appointment.
- When the Visitor visits the premises at the given time and date, the security shall already have prior intimation of the authorisation of visitor, on the Visitor Management Client PC.
- The Security shall check the Visitor's Credentials, and will print a photopass for the visitor.
- Simultaneously, the System shall give a pop-up on the Employee's PC informing him of the arrival of the Employee.
- If the Employee is not on his / her desk, then the system shall, after a preset time delay, raise a GSM based SMS to the Concerned Employee.
- If the Employee is absent on the date of the appointment, then the Shared Database of the Access control and the Visitor Management System shall enable the Security to inform the Visitor of the Employee's absence for the day.
- Else, the Employee shall acknowledge the Pop-up and proceed to meet the visitor at the designated Visitor meeting rooms.
- The System shall thus generate a database comprising information on the visitors, the Employees who meet the Visitors, time and purpose of their meeting.
- This will enable the Company to generate custom made reports to assess Employee productivity, or measure the overall experience of the visitors to the ILBS Premises,

The Main Components of the Visitor Management system shall comprise of :

- Server Application loaded on the Common Application Server.
- Database loaded on the Database Server.
- Web Application loaded on 500 User PCs.

- Client Version Software with Security / Reception with Web Camera and Colour Laser Printer for Photopass Printing.

Building Management System

1.0 Introduction

1.1 The intent of this particular specification is to describe the requirements of BMS.

1.2 The BMS shall comprise a series of intelligent controllers, operator's terminals and peripherals connected by hard – wired network or where identified through higher level networks e.g. Ethernet. It shall be supplied, configured installed and commissioned by the BMS specialist and the client's engineers to be trained by the manufacturer in its full use.

1.3 The BMS shall be supplied, configured and commissioned by the manufacturer or his registered agent, to the requirements of the client or persons responsible in coordinating the technical requirements of the system.

1.4 The Building Automation System (BAS) supplier shall furnish and install a fully integrated building automation system for Institute for Liver & Biliary Sciences Ph-II at Delhi.

1.5 This is a Hospital consisting of three major blocks,

- Clinical block.
- Vivarium Block.
- Academic Block.

1.6 Building Consist of Common 2 Basement, Common 1 Ground, 1 to 3rd Floor is shared by the Clinical block & the Academic Block and Vivarium Block, from 4th to 5th it is shared by the Clinical block & the Academic Block only.

System Performance:

Performance Standards: The system will conform to the following minimum requirements:

i. Graphic Display. An unlimited number of dynamic points can be displayed on any graphic display. The static part of the graphic display will appear within [2] seconds. The dynamic data of a typical graphic display (containing 20 data points) will appear within [5] seconds of the request.

ii. Graphic Refresh. The system will update all dynamic points with current data within [10] seconds.

iii. Object Command from BMS workstation. The maximum time between the command of a binary object by the operator and the reaction by the device will be [30] seconds. Analog objects will start to adjust within [30] seconds.

iv. Object Scan. All changes of state and analog values will be transmitted over the network in a way that any data used or displayed at a controller or workstation be current, within [60] seconds.

v. Alarm annunciation response time. In case of critical alarms, annunciation at the workstation will be within [45] seconds.

vi. Program Execution Frequency. Control applications can run as often as once every [1] second. The Contractor will be responsible for selecting execution times consistent with the HVAC process under control.

vii. Performance. Programmable Controllers can execute DDC PID control loops at a selectable frequency from at least once every [1] second.

viii. Multiple Alarm annunciation. All workstations on the network will receive alarms within [5] seconds.

ix. Reporting Accuracy. Table 1 lists minimum accuracies for all values reported by the specified system.

Table I - Reporting Accuracy:

Space temperature	±0.5°C
Ducted air	±1.0°C
Outside air	±1.0°C
Water temperature	±0.5°C
Delta-T	±0.15 K
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of reading *Note 1
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±25 Pa
Air pressure (space)	±3 Pa
Water pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO_2)	± 50 PPM
Note 1: (10%-100% of scale) (cannot read accurately below 10%) Note 2: for both absolute and differential pressure Note 3: * not including utility supplied meters	

Submittals:

Contractor shall provide wiring diagrams and manufacturers' standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until the Engineer and/or Owner have reviewed submittals for conformity with the plan and specifications. [2] copies are required. All wiring diagrams can be provided to the Owner electronically.

Quantities of items submitted will be reviewed by the Engineer and/or Owner.

Submission by Contractor shall include but not restricted to:

i. A complete bill of materials of equipment to be used indicating quantity, brand and model number.

ii. Provide technical documentation, including:

a) Sequence of operations for each system under control. This sequence will be specified for the use of the Control System being provided for this project;

b) Proposal for Graphical navigation architecture

c) Color prints of sample graphics for each equipment, application within de scope of the project;

d) System architecture drawing showing system configuration, device locations, addresses, and cabling;

e) Project plan identifying the major implementation phases and milestones

f) Detailed wiring diagrams showing all required field and factory terminations. Terminal numbers will be clearly labeled;

g) Points list and the proposed point names, types.

h) Material list with delivery confirmation tracking

i) Datasheets for Building Control Units;

j) Datasheets for Controllers;

k) Datasheets for Auxiliary Control Devices

l) Provide a BACNET Product Implementation Conformance Statement (PICS) for each BACNET device type in the submittal;

m) User Manual for Operator Workstation

Testing and Commissioning Reports and Checklists:

These reports will be automatically produced by and from the BMS system (from Operator Workstation) to ensure integrity of the information. Manual Reports and Checklist will not be accepted.

2.0 Scope of Work

2.1 The scope of work includes design, manufacture, supply, testing and commissioning of Building Management System covering generally the following but not limited to

- Control and Monitoring of Electrical Power distribution system in substation & monitoring of DG Parameters.
- Control and Monitoring of the Common area lighting using timers.
- Control and Monitoring of Street lighting, Landscape and Fountain control based on time.
- Control and Monitoring of Toilet Lighting system with occupancy sensors.
- Control and Monitoring of complete HVAC system including Chiller, AHUs, FCUs, TFAs, HRUs, Mechanical Ventilation system & Smoke Extraction system etc.
- Control and Monitoring of Hydraulic System including R.O System
- Monitoring of Fire fighting system pumps
- Monitoring of Lifts
- Monitoring of UPS

- Interfacing with Fire alarm system

  All other related items and implied/allied items necessary for complete functioning of the system shall be considered.

2.2 The bidder/supplier shall be responsible for engineering and functioning of a complete system including all necessary equipments and accessories fully meeting the intent and requirements of the specifications. Any mismatch in communication protocol, interfacing shall be brought to the knowledge of the client before placement of order.

3.0 Applicable Standards

3.1 The BMS shall meet, or exceed, the following directives in relation to in-built safety and protection against site local lightning strikes, main surges and EMC radiation both towards immunity and emissions which may cause the total malfunction of the system or have an adverse affect on any surrounding equipment.

EMI Emissions standard	-	EN50081-1
EMI Immunity standard	-	EN50082-1
Electrical safety	-	IEC730-1 and CE directives.

3.2 The manufacturer or supplier shall clearly state or indicate in any submission in relation to the supply of the Management System that the product within their scope of supply meets or exceeds the above said standards.

4.0 System Proposed

An Integrated Building Management System integrating, HVAC Control, Part Lighting Control, Hydraulic System, Lift System, UPS System and Fire alarm System on single man machine interface is proposed.

4.1 Following are the sub-systems of BMS system proposed

Controlled and Monitored

a. Electrical Power distribution system in substation

b. Common area lighting using timers

c. Street lighting, Landscape lighting and Fountain lighting based on time

d. Toilet Lighting system with occupancy sensors

e. Complete HVAC system including Chiller, AHUs, Mechanical Ventilation system, Pressurisation system & Smoke Extraction system

f. Hydraulic System including water supply MCC, Water softening plant, drainage & sewage pumps, all water tanks etc. including R.O System

Monitored

a. DG Parameters.

b. Fire fighting system pumps & fire tanks

c. Lifts

d. UPS

Integration with other systems

a. Fire alarm system

b. HVAC Chiller management system

c. Lift Management system

d. Electronic Billing system

Note:

The communication between field devices & Controller and Controller to controller shall be on Backnet protocol. The field devices, controllers and all relevant devices shall be suitably chosen such that all of them operate on Backnet protocol.

5.0 Electrical power distribution system

5.1 Control & monitoring functions proposed

5.1.1	Maximum Demand Control	:	Required
5.1.2	Breaker status monitoring	:	Required as per Clause 5.2.2
5.1.3	Breaker Control	:	Required as per Clause 5.2.1

5.2 Breaker On/Off control and Monitoring (On Real time basis)

5.2.1	Breaker Control (On/Off) at	:	HT Boards including 33KV & 11KV and ACBs of LT EM PCC's & EM A/C PCC
5.2.2	Breaker Monitoring at	:	HT Boards including 33KV & 11KV and ACBs of LT EM PCC's & EM A/C PCC
		:	Incomers of Floor Distribution panels, all panels in Lower & Upper basement Electrical Rooms
		:	All in-comers of HVAC systems
		:	APFC Panels, Battery charger panels and UPS.

5.2.3 Status to be monitored

On/off/trip status & relay indications & alarm:		HT Boards including 33KV and ACBs of LT EM PCC's & EM A/C PCC (for only numerical relays in HT panels)
Local/remote status & service/test status	:	HT Boards including 33KV
On/Off status	:	All other panels as per clause 5.2.2

Whenever any breaker is tripping on fault, it will not be possible to close the breaker on fault till fault is removed. Breaker tripping on fault shall be shown along with Relay Indications. Necessary Interlocking shall be provided in this regard.

5.2.4 Monitoring of all above parameters through	:	Potential free contacts
5.2.5 No. of breakers and control required	:	Refer "IO summary"

5.3 DG & DG Room parameters

5.3.1 DG sets to be monitored	:	Refer "IO summary".

Monitoring

5.3.2 DG Parameters to be monitored	:	DG On/Off status
	:	Trip Status
	:	Engine Fail to start (U/V Trip)
	:	Alternator field failure
	:	Alternator fail to built-up voltage
	:	DG Trip due to earth fault
	:	DG trip due to overload
	:	DG Room Temp
	:	Inlet cooling water temp
	:	Outlet cooling water temp
	:	Cooling water flow OK
	:	Day tank low
	:	Day tank high
	:	HSD tank low

		:	HSD tank high
		:	DG over Speed feedback
		:	Low lube. oil Pressure
		:	Common Engine Fault Alarm
		:	Auto synchronising panel breaker status

Control

5.3.3	DG Parameters to be monitored control	:	Auto sync. panel breaker On/Off

Field Devices

5.3.4	Water flow measurement using	:	Water flow switches
5.3.5	Cooling water temperature measurement	:	Inlet and outlet temperature
5.3.6	By Using	:	Pipe mounting type temperature sensor
5.3.7	Alarm	:	Generate alarm, if temperature is out of band.
5.3.8	Room temperature sensors	:	Shall be provided in DG room.
5.3.9	Day tank and HSD tank fuel level measurement using	:	Flame proof switch
5.3.10	Monitoring of all other parameters thro	:	Potential free contacts

6 HVAC System

6.1 Chillers

6.1.1	Chiller Management Software	:	Supplied by Purchaser (HVAC)
6.1.2	Interfacing software for above software	:	To be supplied by BMS vendor
6.1.3	Direct control of Chiller from BMS vendor Supplied software	:	Not proposed
6.1.4	BMS vendor supplied software shall talk to	:	Chiller Vendor supplied

			Software
6.1.5	Prospective make of Chiller	:	Climaveneta/ Trane/JCI/ Carrier
6.1.6	Separate or Common Computer	:	Common
6.1.7	On/Off Command to the Chiller	:	Shall be sent by BMS
6.1.8	On/Off command by	:	Time based, Optimised, manual
6.1.9	Switching on/off of compressors in Chiller	:	By Chiller manufacturer's software
6.1.10	Alarms display Software	:	By the BMS software & Chiller
6.1.11	Details of alarms (If required) software	:	All the alarms extended by Chiller
6.1.12	Reports generation (If required)	:	From Chiller software
6.1.13	Pre-cooling facility / Night Cooling facility	:	Required
6.1.14	Chillers (quantity)	:	As per IO summary

6.1.15 Controls required

I.No	**Control Description**	**Field Devices**
1	Chiller On/Off Command	Potential free contacts (By HVAC contractor)
2	Chiller Isolation Valve On/Off	Motorised valve (By HVAC Contractor)
3	CDW Isolation Valve On/Off	Motorised valve (By HVAC Contractor)

6.1.16 Monitoring required

I.No	**Control Description**	**Field Devices**
1	Chiller On/Off status	Potential free contacts (By HVAC contractor)
2	Chiller Trip status	Potential free contacts (By HVAC contractor)

3	Chiller Auto/Manual status	Potential free contacts (By HVAC contractor)
4	Chiller Isolation Valve status	Limit switches (Part of motorised valve supplied by HVAC contractor)
5	CHW Supply/Return Temp - headers	Immersion Temperature sensor (By BMS Vendor)
6	CHW Supply/Return Temperature	Immersion Temperature sensor (By BMS Vendor)
7	CHW Supply header flow	Flow transmitters (By BMS Vendor)
8	CDW Supply/Return Temp - headers	Immersion Temperature sensor (By BMS Vendor)
9	CDW Isolation Valve status	Limit switches (Part of motorised valve supplied by HVAC contractor)
10	Water flow switch	DP switch (By BMS Vendor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

6.2 Chilled water pumps control and Monitoring.

6.2.1 Chilled water pump (quantity) : As per IO summary

Controls required

I.No	**Control Description**	**Field Devices**
1	**Primary pumps** Pump On/Off Command	Potential free contacts (By HVAC contractor)
2	**Secondary pumps** Pump On/Off Command	Potential free contacts (By HVAC contractor)
3	VFD On/off command	Potential free contacts (By HVAC

		contractor)
4	Pump Fan speed Control through VFD	Potential free contacts (By HVAC contractor)

Monitoring required

I.No	Control Description	Field Devices
1	**Primary pumps** Pump run status	Potential free contacts (By HVAC contractor)
2	Pump Auto/manual status	Potential free contacts (By HVAC contractor)
3	Pump Trip status	Potential free contacts (By HVAC contractor)
4	**Secondary pumps** Pump run status	Potential free contacts (By HVAC contractor)
5	Pump Auto/manual status	Potential free contacts (By HVAC contractor)
6	Pump Trip status	Potential free contacts (By HVAC contractor)
7	VFD status	Potential free contacts (By HVAC contractor)
8	VFD speed feedback	Potential free contacts (By HVAC contractor)
9	Static Pressure sensor	Immersion Temperature sensor (By BMS Vendor)
10	Pump Bypass status	Immersion Temperature sensor (By BMS Vendor)

6.3 Condenser water pumps control and Monitoring.

6.3.1 Condenser water pump (quantity) : As per IO summary

6.3.2 Controls required

I.No	Control Description	Field Devices
1	Pump On/Off Command	Potential free contacts (By HVAC contractor)

6.3.3 Monitoring required

I.No	Control Description	Field Devices
1	Pump run status	Potential free contacts (By HVAC contractor)
2	Pump Auto/manual status	Potential free contacts (By HVAC contractor)
3	Pump Trip status	Potential free contacts (By HVAC contractor)

6.4 Cooling tower control and Monitoring.

6.4.1 Cooling tower (quantity) : As per IO summary

6.4.2 Controls required

I.No	Control Description	Field Devices
1	Cooling Tower On/Off Command	Potential free contacts (By HVAC contractor)
2	Cooling Tower inlet isolation valves open/close command	Motorised valve (By HVAC Contractor)
3	Cooling Tower outlet isolation valves open/close command	Motorised valve (By HVAC Contractor)

6.4.3 Monitoring required

I.No	Control Description	Field Devices
1	Cooling Tower fan run status	Potential free contacts (By HVAC contractor)
2	Cooling Tower sump water low level	Level Switch (By BMS vendor)
3	Cooling Tower inlet isolation valves open/close status	Limit switches (Part of motorised valve supplied by HVAC contractor)
4	Cooling Tower outlet isolation valves open/close status	Limit switches (Part of motorised valve supplied by HVAC contractor)
5	Outside air temperature and RH monitoring	Outside Air + Rh sensor (By BMS Vendor)

6.5 AHU Control and monitoring

6.5.1 AHUs (quantity) : As per IO summary

Controls required

I.No	Control Description	Field Devices
1	AHU On/Off Command	Potential free contacts (By HVAC contractor)
2	VFD On/Off Command	Potential free contacts (By HVAC contractor)
3	CHW Valve modulation	Motorised valve (By HVAC Contractor)

Monitoring required

I.No	Control Description	Field Devices
1	Auto/Manual status	Potential free contacts (By HVAC contractor)
2	Trip status	Potential free contacts (By HVAC

		contractor)
3	Supply air Temperature	Duct Temperature Sensors (By BMS vendor)
4	Return air Temperature	Duct Temperature Sensors (By BMS vendor)
5	Smoke detector	Smoke detector (By BMS Vendor)
6	Diff. Pressure Switch Across Filter - status	DP switch (By BMS Vendor)
7	Diff. Pressure Switch Across Fan -status	DP switch (By BMS Vendor)
8	Return air humidity	Humidity Sensor (By BMS Vendor)
9	VFD On/Off status	Potential free contacts (By HVAC contractor)
10	VFD speed feedback	Potential free contacts (By HVAC contractor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

6.6 Ventilation fans control and Monitoring.

6.6.1 Ventilation fans (quantity) : As per IO summary

Note:

1. The above mentioned ventilation fans include Basement Ventilation fans, Smoke Exhaust fans, Pressurisation fans, Toilet exhaust fans, Chiller plant room & pump room exhaust fans, Substation ventilation fans & Electrical room ventilation fans.

2. The Control and monitoring parameters for all the above fans are same.

6.6.2 Controls required

I.No	**Control Description**	**Field Devices**
1	Fan On/Off Command	Potential free contacts (By HVAC contractor)

6.6.3 Monitoring required

I.No	Control Description	Field Devices
1	Fan run status	Potential free contacts (By HVAC contractor)
2	Fan Auto/manual status	Potential free contacts (By HVAC contractor)
3	Fan Trip status	Potential free contacts (By HVAC contractor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

7 Hydraulic System control and Monitoring.

7.1 Pumps, UG sump and OH tank (quantity) : As per IO summary (but not restricted to)

7.1.1 BMS System shall be integrated with Hydraulic System including R.O. System

Note:

1. The above mentioned pumps includes Bore well pumps, HVAC makeup water booster pumps, Domestic water pumps, Dewatering pumps, sewage pumps and water softening plant/water treatment plant pumps.

2. The Control and monitoring parameters for all the above pumps are same.

7.2 Controls required

I.No	Control Description	Field Devices
1	Pump On/Off Command	Potential free contacts (By Electrical contractor)

7.3 Monitoring required

I.No	Control Description	Field Devices
1	Pump run status	Potential free contacts (By Electrical contractor)
2	Pump Auto/Manual /Remote status	Potential free contacts (By Electrical contractor)
3	Pump Trip status	Potential free contacts (By Electrical contractor)
4	UG raw water sump High/Low status	Water Level Switch (By BMS vendor)
5	UG treated water sump High/Low status	Water Level Switch (By BMS vendor)
6	OH treated water tank-1 High/Low status	Water Level Switch (By BMS vendor)
7	OH treated water tank-1 High/Low status	Water Level Switch (By BMS vendor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

8 Lighting Control

8.1 Car parking & Common area Lighting

8.1.1 Lighting Control through : Time based

8.1.2 Time delay for Switching on the lamps : Nil, Immediate

8.1.3 Time delay for switching off : Max 2 minutes, adjustable thro' software

8.1.4 Controls required

I.No	Control Description	Field Devices
1	MCBDB On/Off Command	Potential free contacts (By

		Electrical contractor)

8.1.5 Monitoring required

Sl.No	Control Description	Field Devices
1	MCBDB status	Potential free contacts (By Electrical contractor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

8.2 External Lighting

8.2.1 Lighting Control through : Time based

8.2.2 Time delay for Switching on the lamps : Nil, Immediate

8.2.3 Time delay for switching off : Max 2 minutes, adjustable thro' software

8.2.4 Controls required

Sl.No	Control Description	Field Devices
1	MCCB On/Off Command	Potential free contacts (By Electrical contractor)

8.2.5 Monitoring required

Sl.No	Control Description	Field Devices
1	MCCB status	Potential free contacts (By Electrical contractor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

8.3 Toilet Lighting

8.3.1 Occupancy based control through : PIR Sensors

8.3.2 PIR coverage angle, Lenz etc. : To suit site layout

8.3.3 Time delay for Switching on the lamps : Nil, Immediate

8.3.4 Time delay for switching off : Max 2 minutes, adjustable thro' software

8.3.5 Controls required

I.No	**Control Description**	**Field Devices**
1	Contactor On/Off Command	Potential free contacts (By Electrical contractor)

8.3.6 Monitoring required

I.No	**Control Description**	**Field Devices**
1	Occupancy status	PIR sensor (By BMS Vendor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

9 Fire fighting System Monitoring.

9.1 Pumps, UG sump and OH tank (quantity) : As per IO summary

9.2 Monitoring required

I.No	**Control Description**	**Field Devices**
1	Hydrant header pressure monitoring	Potential free contacts (By Fire contractor)
2	Sprinkler header pressure monitoring	Pressure Sensor (By BMS vendor)
3	Terrace Level sprinkler line pressure	Pressure Sensor (By BMS vendor)

	monitoring	
4	Terrace Level booster pump pressure monitoring	Pressure Sensor (By BMS vendor)
5a)	Jockey pump run status & Jockey pump fail to start status	Potential free contacts (By Fire contractor)
5b)	Standby Jockey Pump Run status & Standby Jockey Pump fail to Start Status	Potential Free contacts (By Fire Contractor)
6	Main pump status (electrical driven) & Main pump fail to start status	Potential free contacts (By Fire contractor)
7	Main pump status (Diesel engine driven) & Main pump fail to start status	Potential free contacts (By Fire contractor)
8	Sprinkler pump status & Sprinkler pump fail to start status	Potential free contacts (By Fire contractor)
9	Fire alarm status	Potential free contacts (By Fire contractor)
10	Domestic & Fire water supply header	Flow Transmitter (By BMS Vendor)
11	UG fire water sump High/Low status	Water Level Switch (By BMS vendor)
12	OH fire water tank High/Low status	Water Level Switch (By BMS vendor)

Note: Scope for supplying field devices shall be as indicated in the table. However the cabling, signal communication and co-ordination shall be done by the BMS Vendor.

10 Integration with other systems.

10.1 Fire Alarm System

Fire Alarm System shall have an Integration with HVAC and BMS Systems.Whenever Fire takes place, the concerned AHU shall get tripped Automatically, concerned Ventilation Fan shall get Switched 'OFF', concerned Smoke Extraction Fan, Lift Well Pressurization Fan and Staircase Pressurization Fan shall get switched on Automatically. The status shall appear on BMS with regard to Fire Alarm and concerned AHU

Ventilation Fan, Smoke Extraction Fan, Lift Well Pressurization Fan and Staircase Well Pressurization Fan.

10.2 Lift Management System

Integration shall be done with the Lift monitoring software to monitor On/off status, Fault status, Failure indications, alarms etc.

All necessary ports, cabling, signal communication and co-ordination shall be in BMS Vendor scope.

10.3 Chiller Management System

Integration shall be done with the Chiller management software to achieve the control and monitoring functions as described in clause 6.1.0.

All necessary ports, cabling, signal communication and co-ordination shall be in BMS Vendor scope.

10.4 Electronic Billing System

Integration shall be done with the Electronic billing system to control and monitor the Maximum demand, monitor electrical parameters at different panels.

All necessary ports, cabling, signal communication and co-ordination shall be in BMS Vendor scope.

10.5 DG Synchronization, Auto Load Control & Auto Mains Failure Panel

Integration shall be with DG Synchronization, Auto Load Control and Auto Mains Failure Panel to give status to BMS.

All necessary parts, cabling, signal communication and co-ordination shall be in BMS vendor's scope

11 Run Time Tantalization

Required for	:	All Electrical & HVAC loads, Motors, Lights etc controlled & monitored

by BMS

(a) Totalling period : Shall be selected through programme

- Power failure to controller or keeping the computer in off state shall not disturb the total readings: Yes

(c) RTT (Real time clock) : Required

11.1.0 Totalling period : Shall be selected through programme

12.0 Spare Capacity of I/O points

12.1.0 The DDC controller shall have 20% over all spare capacity with at least one spare of each type of contact per DDC with reference to the IO summary.

13.0 SYSTEM ARCHITECTURE

13.1.0 Central Substation Hardware

The Control stations shall comprise of Personal computers (PC) providing high level operator interface with the system . The terminals shall be capable of providing the operator with the facility for remote system integration, control, retrieval/storage of logged data, annunciation of alarms and reports, analysis of recorded data and the formatting of management reports.

The control station shall consist of the following hardware with all of them suitable for the power supply voltage of 230 V AC ± 10% , 50 HZ + 3%.

- 1.1 Key board : The central station shall be complete with detached 101-keys keyboard which includes full upper/lower case ASCII key set, a numeric pad, dedicated cursor control pad, and a minimum of 10 programmable functional keys.

- 1.2 Colour Monitor : The colour monitors shall be with a minimum 21 inch diagonal non-glare screen and minimum Super VGA resolution of 1024 pixels horizontal, 768 lines vertical and minimum 16 base colors. The monitor shall be with tilt and swivel facilities.

- 1.3 Mouse : For keyboard-less operation, in addition to the enhanced keyboard, a mouse shall also be provided as an alternative user interface for day to day system operation. 2 Nos. mouse pads shall be provided for each mouse.

- Printers : The contractor shall provide printers as specified in the BOQ

- The available PCI slots on the PC shall be used only for communication cards and shall not be utilized for mounting protocol converter cards.

13.2.0 Central Substation Software

13.2.1 User Programmable Software

The system shall have a flexible software package to allow an operator with minimal knowledge of software programming to construct programmes for plant control and management information. All system software shall be field proven. Tenderers shall not quote for an untested and unproven software.

- All programming shall be done in clear English language.

- The system shall hold a complete set of instructions in the software which can be viewed by the operator whilst in the operating mode.

- The system shall provide run simulation of the programmes to allow operator verification before the programme is down loaded to the controllers.

- It shall be possible to assign alarm functions to any programmes created as required.

- Full arithmetic operators shall be available for use in the programmes as required eg: +, -, /, *, ().

- Programmes shall permit the use of comparison statements such as : =, >, <, =< etc.

- Programmes shall permit logical operators to be used such as : NOT, AND, OR, AND MASK.

- Direct reference to any point shall be available to obtain its current value. Such references shall be using standard language such as, ON, OFF, MANUAL, SETPOINT, EXPIRED TIME, PRIORITY, ALARM.

- It shall be possible to refer to time and calendar functions directly, so that DATE, TIME, HOUR, MINUTE functions may be used.

- It shall be possible to use such mnemonics as ABS (absolute value), SQRT (square root), INT (integer), MAX (maximum), AVG (average) etc.

- It shall be possible to set timers so that a timed delay may be introduced before an action is carried out.

- ***The following Softwares shall be provided besides the software for automation system***

DOS	-	Version 6 (or higher)
Memory Manager	-	QEMM Version 5.11 (or higher)
Multitasking	-	Desqview version 2.31 (or higher)
Mouse Driver	-	Microsoft bus mouse 6.2
Data Base Manager	-	Latest Version
Windows XP	-	Update, if any.
AutoCAD 2004		Update, if any.
Maintenance Manager	-	Latest version with details to be submitted along with tender.

- **Management station software shall also be provided all the functions to manage application software packages within a Preemptive Multitasking environment.**

- **It should be possible to run at least five third party software in the multitasking environment.**

- The following user programmes must be processed by the Control Station

1. Operating functions :

- Via graphic management schematics with dynamic display of actual status information.
- manual control of parameters and status variables of the electrical and mechanical plant.
- manual switch of programs which are not part of progress routines.

2. Monitoring functions :

- automatic monitoring of connected plant and equipment
- automatic monitoring of the system (idle or operation)

3. Data visualization functions :

- for the individual processing of operating data for Building Management.

4. In standardised form for :

- trend reports
- consumer statistics
- fault statistics
- maintenance management

5. Display functions :

- for the representation and display of operating data and management information in alphanumeric and graphic form.

6. Management functions :

- for optimisation of energy consumption.

- for rational use of personnel

7. Access control functions :

- different operating levels for all information and all data by way of code word or user key.

8. Commissioning functions :

- for system specific software of the field stations and the management system
- downloading the system specific software to the DDC units.
- testing of the software in connection with electrical and mechanical plant.
- automatic and periodic storage of all system data.

9. Test functions :

- automatic and continuously running test functions for system tests (hardware and operating software) and management system configuration (communication)
- test tools for individual hardware and software components which can be activated manually.
- Self test functions for individual system components which can be activated manually.

13.2.2 Operator Interface

All communications between the operator and the system shall be in clear language, without reference to special code or codes. Generation and editing of software shall be via clear English language menus.

13.2.3 Password Access

- None of the features of the Operators Panel shall be accessible without the user first being required to log on by entering a password.

- Alpha numeric passwords of up to 15 characters shall be available and definable by individual operators.

- It shall be possible to grant or deny access to any terminal and/or functions for individual user. The ability to use this feature itself shall also be definable.

- It shall also be possible to grant or deny access to individual points or groups of points by function or type.

- It shall also be possible to define a timeout value for individual user. Automatic log-off of the operator shall occur if no keyboard or mouse activity is detected during this timeout period. It shall also be possible to allocate an infinite timeout.

- A log of atleast previous 100 users shall be available at each control station. A record of the user's name, the time and date of log ON and log OFF shall be available from this file.

- Password summary shall be available to the operators with the highest level of access. The summary shall display all passwords and their associated parameters.

- Password data base shall be stored in multiple locations in an encrypted form so that the failure of any one device shall not make the system inoperative.

13.2.4 Control Station Graphics Capabilities

The work stations shall have Graphics as the basis of operation. The software shall have following advanced techniques for ease of operation :

- Colour banding of screen displays shall be provided for display and differentiation of normal and abnormal signals. This shall allow operator instant recognition and response to critical building operation.

- To provide instantaneous confirmation to system operator of equipment status, graphic screen animation shall be provided. This shall allow full color animated displays of equipment in site layouts, building floor plans, and other system configurations. All graphic displays shall be online programmable via keyboard or mouse selection of graphic library stored symbols and system profiles. Fully implemented graphic displays are to be provided for all systems so identified in the Input/Output Summary section of this document.

- Split screens capability shall be provided to allow operator to observe multiple dynamic graphic screens at the same time to enable operator to manage several separate building operation tasks concurrently.

- To enable operator to "find" his way in and out of the system, a stacked display of windows shall be included to provide orderly reference. Operator option of enlarged full screen display at any penetration level shall also be included.

- Alarm class differentiation shall define coloration, and storage requirements for different alarms.

- Graphic driven point identification and selection shall be provided to allow operator to select a point by "clicking on" the graphic symbol representing the point type. Consequently display will appear to enable the operator to select the desired command.

- The system shall be capable of running programs in both the foreground mode and background mode simultaneously. The system running only foreground "window" while keeping the other programs dormant in the background "window" shall not be acceptable as this slows down the availability of control and essential information to be made available to the operator in the system.

- Capability of on-line graphics generation shall be a major requirement i.e. the operator shall have the ability to create new graphics on-site from a menu of symbols.

- Historical system trouble, fault, false alarms shall be stored on line in the hard disk for trouble analysis.

- It shall be possible to define up to 12 functional categories in the plant schematic each of which shall be removable from the screen individually. This shall allow the operator to delete temporarily any equipment and have a better overview of the other sections of the system.

- Maintenance software such as inventory control, work orders shall also be on-line with the historical data- file for proper maintenance of the system.

- Data Base Manager shall manage all data on an integrated and non-redundant basis. It shall allow addition and deletions to the data base without any detriment to the existing data. Cross linkages shall be provided such that no data required by a software program can be deleted by the operator until that data has been deleted from its respective programs.

- Dynamic data such as temperature and humidity values, fans and motor status, alarm point condition, etc. shall be embedded in the graphics as the sensing location. Points in alarm condition shall annunciate by colour changes and flashing/blinking icon, symbol, or value.

- Command-able points shall be uniquely identified by colour and/or discrete symbol and shall be directly addressable and command-able from the graphic display. It shall not be necessary for an operator to type in command request or point names. Direct entry of command-able point address or positioning of the cursor to the point shall cause a display of associated command states for digitals, the set point value and valid range for analogs. Cursor positioning shall be via a “mouse”.

- In order to allow the operators to view graphics in greater detail, zoom /pan display feature shall be provided to return zoomed/panned graphics to their original status. A “return to original” feature shall also be provided. The mouse shall be used to pan in all directions in real time, and to jump, from any section of the plant schematic directly to another section or to another level.

13.2.5 User Interface

The operator panel on a terminal shall provide the primary interface for operator access to the BAS while also providing a vehicle for the annunciation of alarms and the reporting function. The operator shall have the option of switching between a text based and graphic based user interface at any time. In particular following standard functions shall be provided:

- It shall be possible to carry out the following commands by use of dedicated function keys on the keyboard and by the mouse :

  - ON - digital points
  - OFF - digital points
  - AUTO - analogue and digital points

- SET TO VALUE - analogue points
- ALARM REVIEW
- POINT TYPE REVIEW
- POINT GROUP REVIEW
- HOURS RUN REVIEW
- REVIEW CANCEL
- GRAPHICS ENABLE
- HELP
- ALARM ACKNOWLEDGE

- It shall be possible to add new points, and reconfigure or modify existing points without taking any part of the system off-line. It shall be possible to change designation of operator passwords, access levels, point segregation and auto sign off, designation of backup consoles and printers. It shall also be possible to add/change descriptors for points, segregation groups and access levels, and action messages for alarms and trouble condition, system/point enable/disable, input or output value, and assignment of alarm/warning limits. All additions and modifications shall be on-line programmable via operators keyboard and then down line loaded to distributed processing units.

- It shall be possible to address plant, zones, points etc., using clear language descripters. Each individual point may also be identified by a unique alpha-numeric mnemonic address entry. Simple key names may be assigned to points to allow direct display. These key names shall be fully operator assignable and depending on how frequently they have to be accessed, they may be as simple as one, two or three characters or as lengthy as 20 characters.

- The operator shall be able to access any point on any graphic without going through the penetration path. Graphics shall be menu-driven. Direct access to graphics shall be menu selectable wherein the operator may select optionally by entering the name of the graphic system desired or by selecting the desired graphic via cursor positioning .

- It should be possible to identify some points which are frequently addressed as “frequent access” points. This listing shall be selectable from a screen top menu bar drop down menu item with a user address, descriptor and value/status of each “frequent access” point displayed.

- A wild card search utility should be provided which shall be operated by a partial data entry. For example, by listing chiller 1, all chiller no. 1 points shall be listed.

- The information displayed for individual points during a review shall be :

    - its unique mnemonic address
    - its current state or value (in Engineering units)
    - its type of point (analog/digital, input/ output)
    - any secondary or tertiary value
    - reason for state, if applicable

- An Electronic message facility shall be provided on the operator station for any operator to enter a message to another operator of the same station or different station, by selecting the receiving operator's ID and entering the message. When the operator with a queued message, signs onto the operator station, a "mail message waiting" prompt shall be issued. Upon displaying a mail message, the display shall prompt the operator with three message options to execute, delete, print, and save. Messages shall also include the senders personal ID and a brief title or subject description.

- Dynamic data shall be automatically updated on the central station . Manual update shall also be provided via a screen update key.

- It shall be possible to enter any of the subroutines such as the editor functions, or the Data Manipulation function from the central station without closing down the terminal or the programs currently running.

- The operator shall be provided with the facility to override the use of portable operators terminal.

13.2.6 Help Facility

- Software shall be provided to facilitate programming and storage of the system operation manuals in the hard-disk. The operation manual shall be retrieved by On Line Help mode so as to enable the operator to self learn the system operation, command, or function as and when needed.

- This `help' facility shall be made available to the operator by use of a dedicated key or a single key click on the mouse. A minimum help shall be available for every menu item and dialogue box.

- The facility shall contain both text and graphics to provide information about the selected function directly.

- The information provided shall be in simple clear language and shall be capable of being added to or modified by an authorized operator.

13.2.7 Alarms

- Multiple priority levels of alarm shall be made available. Priority levels shall be deemed Critical Alarms and Non- critical (general) Alarms. Normally, critical alarms shall take precedence over non-critical alarms, and high priority over low priority.

- Each analog point shall have the following limits defined ; wherever required

    - High priority critical alarm limit
    - Low priority critical alarm warning limit
    - Low priority warning limit
    - Low general alarm limit

- When an analog point goes outside the low priority critical alarm limit or Low priority warning limit, a user defined warning message shall be directed to the appropriate alarm printers at the control station.

- The Warning limits shall be used to monitor controllability, not comfort conditions. The alarm limits shall be used to monitor comfort conditions. When a set point is changed, the warning limits shall automatically change while the alarm limits shall not change.

- When an analog point goes outside any of the limits defined, a user defined alarm message for that level shall be directed to the appropriate alarm printer and to respective operator workstation. Alarm message shall require operator acknowledgement.

- When a digital point goes into alarm, a user defined alarm message shall be output to the appropriate alarm printer and to respective control station. Alarm messages shall require operator acknowledgement.

- When a point is overridden by operator command from an operator workstation or a local workstation, an alarm message shall be output to the appropriate alarm printer and to respective operator workstation. Alarm messages shall require operator acknowledgement.

- When a point returns to normal, the event shall be recorded in control stations as 'Return to Normal'.

- The Operator workstations shall be capable of displaying a list of all points in alarm for the building in a single summary. Systems which require the operator to make a separate summary for alarms, shall not be acceptable.

- Annunciation: Alarms shall be annunciated at a terminal by an audible tone and icon. Critical alarms shall be defined by a different colour than non-critical alarms.

- Printing: Alarms shall automatically be printed on the defined alarm printer. The printout shall contain the address, state or nature of the alarm, alarm priority, and time and date of occurrence. It shall be possible to route alarms to any printer on the system, in case the allotted printer fails.

- It shall be possible to produce a user definable full text message to accompany the annunciation of any alarm. This shall provide further information about the alarm and any action required to be taken by the operator or indicate that action is automatically programmed in the system. These messages shall be automatically printed on a designated printer. There shall be no practical limit to the length of messages created.

- Acknowledgement: It shall be necessary for all alarms to be acknowledged by an authorized operator. The facility shall exist for an additional message to be appended at the time of acknowledgement to provide further information as to any action taken. Acknowledgement of alarms shall be automatically printed and will

indicate the time, date, and any message generated by the operator. Alarm silencing shall be by the authorized operators by pressing the silence key.

- Alarm Clear: When alarms are cleared, then a message shall be produced to indicate the description of the alarm point, its current state, and the time and date.

- Disk Records: With the exception of extended text messages, all the information produced above, alarm annunciation, acknowledgement, and clearing, shall be automatically recorded on the fixed disk for historical purposes.

- Alarm Inhibits: It shall be possible to inhibit the transmission of alarms in the following ways :

    - Operational Inhibits to allow time for stabilization of power after the normal power is restored.

    - ***Transient Inhibit - to make allowance for fluttering contacts or allow internal responses.***

    It shall be possible to select time periods for inhibits (i) and (ii) and may be applied when entering into alarm, out of alarm, or both.

- Point lockout: It shall be possible for the operator to lockout the control for any point, to force it to remain in its current state. A summary showing locked out points shall be available. Systems which require the operator to make a separate lockout summary shall not be acceptable.

- Alarm Review: Points in alarm shall be displayed on the operators panel using the alarm review function.

13.2.8 Logging

- It shall be possible to log the status or value of system points at regular intervals or on change of state and store this on hard-disk at any of the central station.

- It shall be possible to archive this information for future reference.

- In the case of timed interval logs, it shall be possible to specify a time interval (in minutes) and the points which are required to be logged.

- Storage of logged information shall be able to be carried out in any of three ways, single-shot, roll- over, or split. These are defined as follows :-

    - Single-shot : In this type of file, logging shall be carried out only during a pre-defined period for which the start and finish time and date shall be configurable.

    - Roll-over : This file shall be wrap-around where oldest data shall continuously be overwritten by new incoming data. It shall be possible to configure the number of records to be stored or the duration in hours, days or months before wrap around occurs.

- Split Data shall be continuously stored in a series of files automatically created. The change-over or creation of subsequent files shall be created by splits at user-defined boundaries. The boundaries shall be able to be defined by duration (hours, days, months) and by time and day of the first split.

- Logging files shall be terminal based not system based, to provide true multi-terminal capability.

- Data produced by the logging facility must be able to be used by standard spread-sheet package for the analysis of information and the preparation of management report.

- In addition to the above, the data may be presented in a simplified customised package. The package should have the following features as minimum :

    1. Charting of logged data on disk in line graph, bar graph or pie format.
    2. Presentation of logged data on disk in tabular format.
    3. Charting of dynamic data (up to 8 points) in real time.
    4. Presentation of dynamic data in tabular format in real time.
    5. Selection of Auto/ manual scaling of X(time) axis and Y(variable) axis.
    6. Tailoring of charts by selection of line width and background colours.
    7. Optional grid overlays (full and dotted lines).
    8. Selection of horizontal/ vertical arrangement of windows or a `cascade' presentation.
    9. Multiple Windows.
    10. Printing of completed presentations.
    11. User configurable data selections.
    12. Optional display of point titles.
    13. Selection of primary or secondary values for display.
    14. Presentation of both analog and digital values (ON/OFF etc.).

13.2.9 Report Generation :

Standard reports shall be provided, which shall be operator selectable to appear on the operator station, any selected printer or both. A "terminate report" command shall be available to allow the operator to stop any report in the process of being printed. Standard pre-formatted reports to be provided shall include :

Point summary reports may be requested at any penetration level. Point summary reports shall include the current value/status and condition, point descriptors and all relevant information. Point summary reports shall be selectable for all points.

All reports shall be capable of being scheduled to run at a specific time and/or interval via an operator function supported by necessary data entry templates and interactive prompts.

As a minimum, the system shall provide the following summaries:

Point summary

- Alarm summary
- Limits summary
- Lockout summary
- Off-line summary
- Override summary
- Utility summary
- Point status (alarm, locked out, off-line, override)
- Point name
- Point status/value (automatically updating)
- Engineering units.

The alarm summary shall list all points in alarm in the selected system. It shall be possible to print on a single summary, all points in alarm in the building. As a minimum, the alarm summary shall include :

- Point name
- Point status/value (when alarm occurred)
- Alarm message
- Date and time of alarm occurrence
- Date and time of acknowledgment and Operator I.D.

The limits summary shall list all the alarm limits, and warning limits.

The lockout summary shall display points in the selected system which have either reporting or triggering locked out.

The off-line summary shall display points in the selected system which have lost communication with the system.

The override summary shall display points in the selected system which have been overridden by operator command.

The utility profile shall display the total consumption, measured peak for the current period and the previous period.

Trend reports shall allow the operator to randomly select logical group of points to be recorded at selectable time intervals. It shall be possible to assign up to ten variables to each trend report. The format, headers, footers, and calculations shall be selectable by the operator. The trend report shall be stored to disk and shall be subsequently capable of being displayed, and/or printed by the operator.

Dynamic trends shall provide up to eight points and show real time activity of the associated points. This information shall be printed and/or displayed in numeric, bar chart, curve plot, pie chart, etc., as selected by the operator. Graphic plots shall allow a unique color for each point. Sample interval of points selected for dynamic trend shall be user selectable. 3- Dimensional dynamic trending must be provided in the system.

Alarm and run time reports shall be automatically issued to assigned printers immediately upon occurrence, and shall consist of the point with engineering unit, the time, and the date, and the alarm message.

13.2.10 DATA STORAGE:

A history file capability shall be provided to allow automatic storage of certain records plus allow the operator to selectively direct critical real time system data and activity to a mass storage device for later recall and analysis.

- All alarm and return to normal activity shall automatically be routed to history files. Alarms and return-to-normals shall include warning and alarm threshold violations with no-response, trouble, run time exceeded, demand alarms, and command failures. It shall be possible to request a report by specifying points of interest, the time window of interest, and the type of alarms of interest. Locking out or disabling of points shall also be historically stored and output in the all- type reports.

- Operator shall be able to select, via the CRT terminal keyboard, those analog and digital inputs and outputs to be stored and the interval at which samples are taken.

- It shall be possible to access software packages so that the operator may format display or printouts in the form of :

    - Spread sheets.
    - Bar charts.
    - Curve plots.

- History files shall be the source data for stored trend reports to be used for records and system analysis. Operator shall be able to select specific points to be trended, the time period of the trend, the sample interval, and time at which the report is printed. Trend output format shall be as specified for trend logs (shaded, un-shaded etc)

13.2.11 UTILITIES

The Central Station personal computer (P.C.) shall be provided with the following menu selected graphic system utilities or desktop application packages. The system provided must be capable of running standard software packages concurrently with the real time system. System should be capable of supporting third party software packages like spreadsheet, word processing etc.

- The base system software shall include a CRT “windowing” feature to allow the operator to monitor the real time system and use the third party software simultaneously.

- All third party software packages identified shall have access to the system historical data base.

13.2.12 TIME SCHEDULING

- There shall be real time clock facility to help in time scheduling. The scheduling feature shall not be dependent on a central database or an operator workstation.

- The following commands shall be able to be time scheduled to be issued at a later day and time from the operator workstation or portable workstation:

  - Start and stop a point
  - Adjust analog value
  - Change set point

- The following commands shall be able to be time scheduled to be issued at a later day and time from the operator workstation:

  - Change alarm limits or warning
  - Lock/unlock point reporting or point control
  - Demand limit target setting
  - Load rolling target setting
  - Reset tracking period for energy statistics
  - Trend point enable/ disable for a point
  - Totalization enable/ disable for a point
  - Reset totalization value

- The following summaries shall be able to time scheduled to be printed or stored in a disk file at a later day and time from the operator workstation :

  - Standard point summary
  - Alarm summary
  - Off-line summary
  - Override summary
  - Disabled summary
  - Lockout summary
  - Utility summary
  - Alarm limits summary

- Commands shall be able to be issued repeatedly on specified days of the week at specified times.

- A system wide calendar shall be set up to define each day as:

  - Regular day
  - Special day
  - Holiday

- The system wide calendar shall be stored in multiple locations so that the failure of any one device does not cause the system to fail. The calendar shall automatically accommodate the leap year and the turn of the century. The calendar shall allow the days to be scheduled one year in advance from the current system date.

- Separate schedules shall be stored for :

  - Regular days
  - Special days
  - Holidays

- The system shall accept one-time schedules to accommodate overtime usage. One-time schedules shall be automatically deleted from the system after execution. The system shall allow one-time schedules to be programmed up to one year in advance.

- After recovery from a power failure, the system shall determine any time scheduled commands which should have been issued during the period that the power was off. These commands shall automatically be issued.

13.2.13 Point History

- For every analog point in the system, a 24 hour record of the value sampled on regular interval shall be maintained. The operator shall choose whether samples older than 24 hours shall be discarded or archived . The most recent 24 hours of analog point history shall be able to be displayed at the Control Station.

- For every digital point in the system, a point history of the last 10 change of states shall be maintained. The operator shall choose whether point history previous to the last 10 change of states shall be discarded or archived.

  The most recent 10 samples of digital point history shall be able to be displayed at the Control Station.

- Point history samples with time/date shall also be taken under the following conditions :

  - Point in alarm/return to normal
  - Point overridden/released by operator
  - Point on-line/off-line
  - Point reliable/unreliable

  A report shall be available showing all points for which point history is being archived.

- The system shall provide point history graphs for analog/digital points.

13.2.14 Point Trend

- The trend feature shall be able to record any of the following parameters for any point :

  - Point value
  - Point alarm status
  - Controlling feature
  - Operator override flag
  - On-line/Off-line flag

- The operator shall be able to select points and define any interval on which samples may be taken.

- For long term storage of samples, trend data shall automatically be updated.

- A report shall be available listing all points being trended. The report shall display :

  - Trend status
  - Point name
  - Parameter being trended
  - Display units
  - Sample interval
  - Number of samples taken.

- A trend for a point shall be able to be started either by operator command or according to a time scheduled command. A trend for a point will end as a result of an operator command, time scheduled command or when the required number of samples have been collected.

- Trend samples shall be displayed in either tabular or graphical format. A minimum of eight trended points shall be able to be displayed concurrently on a graph or report.

- The trend graph display shall automatically scale the value and time axis to display all samples. From the trend graph, the operator shall be able to select and read the instantaneous value of any previous sample.

- The trend point graphing capability shall be a built-in feature of the system and shall not require operator set- up. Systems which require trend point data to be exported to third party software shall not be acceptable.

13.2.15 Totalization

- For every digital point, the system shall be able to calculate:

  - Cumulative on-time
  - Cumulative off-time

- For every point, analog and digital, the system shall be able to calculate:

  - Cumulative time in alarm

- Cumulative time overridden by operator
- Cumulative time off-line

- Time totalization shall have a resolution of one minute or less.

- Time totalization shall be displayed in hours.

13.2.16 Demand Limiting / Load Rolling

- The system shall calculate the instantaneous demand based on the sliding average of the previous 30 minutes of the consumption.

- The system shall calculate a predicted demand based on the sliding window average of the previous 20 minutes of consumption. The predicted demand shall be used for control calculations.

- The operator shall be able to "lock" a load so that it is ineligible for shedding by demand, limiting or load rolling.

- The operator shall be able to use the scheduling feature to program time/days for a load to be locked and unlocked.

- The operator shall be able to use the scheduling feature to program time/days for target values for the demand limiting and load rolling features.

- The demand limiting/ load rolling features shall allow a minimum of four priority groups to be defined. Within a priority group, a rotational shedding algorithm shall be used.

- The operator shall be able to define a target reduction of electrical consumption and the load rolling feature shall turn off equipment to meet this target.

- The operator shall be able to define a demand target that is not to be exceeded and the demand limiting feature shall analyse trends and electrical demand and turn off equipment when a demand peak is anticipated.

- The demand limiting and load rolling features shall be fully integrated with all other features so that the following safety parameters are maintained:

- Minimum on time
- Minimum off time
- Maximum off time
- Maximum number of cycles per hour

- At the end of the minimum off time, a comfort parameter, such as a temperature, shall be sampled. If the comfort parameter is in alarm, the point being controlled shall be turned on.

- The following statistical data shall be maintained :

- Date / time of start of current period
- Total consumption for current and previous period
- Actual peak demand with time/ date for current and previous period.
- Instantaneous demand
- Interval demand
- Total shed loads

- The operator shall be able to define the tracking period for the statistical date as:

  - Hourly (automatic reset)
  - Daily (automatic reset)
  - Weekly (automatic reset)
  - Monthly (automatic reset)
  - Manual reset

- To provide the operator with an opportunity to manually shed loads that are not available to demand limiting or load rolling, the operator shall be notified when the demand limiting or load rolling run out of loads to shed.

- To advise the operator when the performance is outside of expectations, the operator shall be notified when the demand peak target or load rolling target is exceeded.

13.2.17 Data base Manager

Control station software shall include a data base manager to allow the data to be managed on an integral and non-redundant basis. It shall be able to make additions and deletions to database, without affecting the existing data.

- ***Site specific data manipulation software***

A site specific data manipulation software shall be provided to allow the user to modify and tailor the BAS software to the changing requirements at the site. The modifications shall be carried out on-line.

- *The contractor at the time of submission of tender shall list out the modification capabilities of the system.*

14.0 DIRECT DIGITAL CONTROLLER

14.1.0 Direct Digital Controller (DDC) Hardware Requirement:

- DDC controllers shall be capable of fully “stand- alone” operation i.e. in the event of loss of communication with other DDC’s or Control Station, they shall be able to function on their own.

- The controllers shall consist of minimum 16-bit microprocessors, based with EEPROM for operating system (O.S.) and a battery backed RAM for storage of operating data.

- The memory available to the controller board as working space for storage of the Operating system software and data files shall be decided on the basis of number of points being controlled by them.

- Each Controller shall have a nickle-cadmium/lithium battery to support the full operation of the RAM up to 12 hours in the event of a localised mains failure. The battery shall not be required to supply power to actuators, valves, dampers etc.

- In addition to the above battery reserve a further battery shall be provided to retain the RAM for a minimum of 2 days, after the expiration of the standard battery. In case the memory is stored on EEPROM, the battery backup will not be required.

- A low battery alarm shall be provided with each Controller and with an indication at the Control Station.

- The Controllers shall have proportional control, Proportional plus Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc, all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.

- The controllers shall have a resident real time clock or software clock for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with other clocks in the network.Back-up power shall support the clock. Upon power restoration all clocks shall be automatically synchronized.

- The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory, and capacity to accommodate a maximum of 48 input/output (I/O) hardware points (with or without an expansion board). DDC's with a lower capacity of points shall preferably be provided at the locations with relatively less input/output points.

- If the controllers provided by the contractor have the configurable plug in function cards, then the following minimum specifications shall have to be met :

    - In addition to the basic outstation, a minimum of two slots shall be provided for the insertion of plug-in function cards.

    - The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.

- The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Owner/ Consultant.

- DDC's shall have 20% as overall spare capacity & at least one spare of each type shall be provided.

- All DDC controllers shall be capable of handling voltage, milli-ampere, resistance or open and closed contacts inputs in any mix, if required.

  Analog inputs/outputs of the following minimum types shall be supported :

  i) 4-20 mA.
  ii) 0-1 volts.
  iii) 0-10 volts.
  iv) 0-5 volts, and
  v) 2-10 volts.
  vi) Resistance Signals (either PTC or NTC)
  (PT 100, PT 1000, PT 3000, Balco 500, NI 1000)

  Digital input/output types to be supported shall be, but not limited to the following :

  i) Normally-open contacts.
  ii) Normally-closed contacts.

  Modulating outputs shall be true proportional outputs and not floating control type.

- Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.

- All board terminations shall be made via plug-in connectors to facilitate trouble-shooting, repair and replacement. Soldering of connections shall not be permitted.

- 1.1.15 Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, and Bus Error. All LED's shall be visible without opening the panel door.

- 1.1.16 It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring and communications) in the event of a localised mains failure.

- Controllers requiring fan cooling are not acceptable.

- There shall be the facility for accessing controller data information locally, via a portable plug-in keypad display which can be common to all controllers and normally removed to prevent unauthorized tampering. Alternatively each controller shall have a keypad and display integral with its casing for local interrogation and adjustment. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.

- In case the Portable operator Terminals (POT) are required to programme the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.

- The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel.

- It shall be possible to add new controllers to the system without taking any part of the system off-line.

14.2.0 Direct Digital Controllers Capabilities :

- The Controllers shall have a self analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip "Passed" or "Failed" the diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

- Operating system (O.S.) software for controllers shall be EPROM resident. Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.

- In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.

- In the event of memory loss of a Controller, or the expiration of back-up power, on start-up of the unit the necessary data-base shall be downloaded automatically and without operator instruction. Controllers requiring a manual intervention for the re-boot of software are not desired.

- Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.

- Controllers must be able to perform the following energy management functions as a minimum.

    - Time & Event programs
    - Holiday Scheduling
    - Maximum and Distributed power demand
    - Optimum start and stop program
    - Night purge

- Load reset
- Zero energy band
- Duty cycle
- Enthalpy analysis and control
- Run Time Totalization
- Sequencing and Optimization
- Exception scheduling

Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the Consultant.

- The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHU's and chiller system so as to provide the most efficient and optimised controls at different load conditions. The energy management programs shall update their parameters based on past experience and current operating conditions.

- Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic. Tenderers shall indicate their proposed system alarm handling capability & features.

- Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.

- It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.

- Distributed power demand program shall be based on a sliding window instantaneous demand trend algorithm. The DDC interfaced to the demand meter shall calculate the demand, forecast the demand trend, compare it to the established demand limits, and initiate load shedding or re-establishment of loads as required. Shedding shall be on a sequential basis with least important loads shed first and restored last.

15.0 PORTABLE OPERATORS TERMINAL (POT)

- POT shall be provided to allow operator readout of system variables, override control and adjustment of control parameters. The POT shall be portable and plug directly into individual controllers for power and data. The POT shall be password protected.

- The minimum functionality of POT shall include :

- Set points to a fixed value or state.
- Display diagnostic results.
- Display sequentially all point summary and sequentially alarm summary.
- Display/change digital point state, analog point value.
- Display/change time and date.
- Display/change analog limits.
- Display/change time schedule.
- Display/change run time counts and run time limits.
- Display/change time and/or event initiation.
- Display/change programmable offset values.
- Access DDC initialization routines and diagnostics.
- Enable/disable points, initiators and programs.
- Display/change minimum ON/OFF and maximum OFF times.

- The POT shall be complete with command keys, data entry keys, cursor control keys and a 24 character liquid crystal alphanumeric display. Access shall be via self prompting menu selection with arrow key control of next menu/previous menu and step forward/backward within a given menu.

- Connection of a POT to a controller shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or interfere with Control Station commands and system modifications.

- Connection of POT at any controller shall provide display access to all controllers on that bus. In case the controller has a fixed LCD display and entry keyboard, then the display access shall be available on each screen.

- It should be possible to override the commands given through POT by the Operator Control Station.

16.0 DATA COMMUNICATION

- The communication between controllers shall be via a dedicated communication network as per manufacturer's standards. Controllers microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

- Each controller shall have equal rights for data transfer and shall report in its predetermined time slot. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

- The communication network shall be such that:

- Every DDC must be capable of communicating with all DDC's.

- Network connected devices with no messages to transmit shall indicate "No failure" message each cycle. Lack of this message after successive retries shall constitute a communication or device failure.

- Each controller is to be provided with a communication watchdog to assure that an individual controller does not permanently occupy the bus. If a controller is detected as occupying more time than usual, then it shall be automatically shutdown and an alarm sent to the Control Station.

- Error recovery and communication initialization routines are to be resident in each network connected device.

- For reliability, maintainability, and performance, communication network shall be extendable to 4,000 feet without active links, hubs, or repeaters, Active devices required within buses under 4,000 feet long shall be fully transparent (without compromising any parameter) and totally redundant (including power supply) to provide the reliability specified.

- The communication protocol shall incorporate CRC (Cylic Redundancy Check) to detect transmission errors. Parity bit error checking shall not be acceptable. Vendors to give details for their system error checking capability.

- Single or multiple stand alone controller failures shall not cause loss of communication between active control panels connected on the communication network. Full communication shall be sustained as long as there are at least two operational stand alone control panels active on the communication network.

- All the System Integration Units shall be linked together on a Local Area Network.

- The communication network shall include provision for automatically reconfiguring itself to allow all operational equipment to perform as efficiently as possible in the event of single or multiple failure.

- The communication network shall follow the recommendations of ISO 7498 or equivalent standard. The BAS supplier shall be required to provide details of standards to which their system conforms.

17.0 Field Input/Output Devices

17.1 List of Field Devices and Quantity : Refer BOQ

17.2 ELECTRIC AND ELECTRONIC CONTROLS RELATED EQUIPMENT

17.2.1 General Requirements

All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

17.2.2 Ancillary Items

When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items :

(i) Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment is mentioned in the respective section.

(ii) Pipework Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13 mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

(iii) Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

17.2.3 Additional features

(i) **Concealed Adjustment** : All two position switching devices shall have concealed adjustment unless detailed otherwise in the Schedule of Quantities.

(ii) **Operating Voltage** : All two position switching devices shall operate on 230 v a.c and all accessible live parts shall be shrouded. An earth terminal shall be provided.

17.3 TEMPERATURE SENSOR

Temperature sensors for space, pipes and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications :

17.3.1 Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least ± 0.33 degrees F and sensivity of at least 2 ohm/F.

17.3.2 Immersion sensors shall be provided with separate stainless steel thermo well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm2.

17.3.3 The connection to the pipe shall be screwed ¾ inch NPT (M). An aluminium sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.

17.3.4 The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.

17.3.5 Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.

17.3.6 Outdoor air temperature sensor shall be provided with a sun shield.

17.3.7 The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

17.3.8 The temperature sensors may be of any of the following types:
- PT 100, PT 1000, PT 3000
- NI 100, NI 1000
- Balco 500.
- Thermistor

17.4 FLOW METER

17.4.1 Water flow meters shall be paddle type. The housing shall have IP 55 protection. Vendors shall have to get their design/ selection approved by the Consultant, prior to the supply.

17.4.2 The exact ranges to be set shall be determined by the contractor at the time of commissioning. It should be possible to 'zero' the flow meter without any external instruments, with the overall accuracy of at least ± 1% full scale.

17.5 PRESSURE TRANSMITTER FOR WATER

Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable). Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilised condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of -10 °C to 60 °C with ambient ranging between 0 ° C to 55 ° C.

17.6 DIFFERENTIAL PRESSURE SWITCH FOR PIPE WORK

These shall be used to measure pressure differential across suction and discharge of pumps. The range shall be as specified in the data sheet. Switch shall be ON with increase in differential. Housing for these shall be weather proof with IP 55 protection. The pressure switch shall be capable of withstanding a hydraulic test

pressure of 1.5 times the working pressure. The set point shall fall in 40-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

17.7 DIFFERENTIAL PRESSURE SWITCH FOR AIR SYSTEMS

These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

17.7.1 The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 230 VAC, 1 A rating.

17.7.2 The switch shall be supplied suitable for wall mounting on ducts in any plane. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.

17.7.3 The set point shall fall within 40%-70% of the scale range and l have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

17.8 AIR FLOW SWITCHES

Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 2 NO/NC potential free. Site adjustable scale shall also be provided.

17.9 AIR PRESSURE SENSOR

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive coupling which would electro-magnetically give an output suitable for the controller. The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

17.10 WATER FLOW SWITCH

These shall be paddle type and suitable for the type of liquid flowing in the line. Output shall be 2NO/2NC potential free.

17.11 LEVEL SWITCH

The level switches shall have to meet the following requirement :

Type	:	Float Type/Capacitance type/Conductivity type
Mounting	:	To suit application.
Connection	:	Flanged ANSI 150 lbs RF Carbon steel
Float material	:	316 SS
Stem Material	:	316 SS
Output	:	2 NO, 2 NC potential free
Switch Enclosure	:	IP 55

17.12 TWO WAY MOTORIZED BUTTERFLY VALVE

17.12.1 Valve

a.	Type of valve	:	Butterfly Valve.
b.	Body Material	:	Carbon steel ASTM A 216
c.	Body seat ring (if applicable)	:	Gr WCB
d.	Vane	:	SS-316
e.	Packing	:	Teflon
f.	Mounting Stool	:	Required.
g.	Shaft	:	SS-316
h.	Seat	:	Nitrile rubber
J	Fasteners	:	SS-316

17.12.2 Actuators

Type	:	Electic .
Duty.	:	On/Off (Maximum 50 operations per day)
Motor power supply	:	230 V AC or 415 V 3-phase
Travel limit switches	:	2 Nos
Torque limit switches.	:	2 Nos
Hand wheel	:	Required
Speed	:	Approx 150 mm/min

18.0 Installation

The BMS system shall be installed complying with the following codes and regulations.

- National and local statuary regulations.
- Health & safety at Work Acts.
- IEE Regulations
- Equipment manufacturers instructions.
- Regulations and conditions of utilities suppliers.
- Any statutory Safety Guides.
- Safety Guidelines for contractors working on the clients individual premises.

18.1 Where cables are connected to sensors measuring extreme heat, the

necessary protections shall be provided for the connecting cables.

18.2 BMS specialist should ensure the necessary clearance for BMS data cables from the electrical power cables to avoid any interference and resulting induced voltages.

18.3 Where DDCs having potentially different mains voltage supply feeds, additional low voltage relay circuits shall be employed. A notice shall be fixed inside the DDC detailing how all main feeds into it can be isolated.

18.4 Network cables shall be supplied with at least one spare pairs to allow for future system expansion.

18.5 Each DDC shall be provided with a schedule identifying the points connecting into the I/O terminals inside the panel door.

18.6 Tenderer shall arrange the tools and tackles at their cost required for installation and commissioning.

19 Commissioning

19.1 The commissioning work shall be taken up in two stages viz: pre-Commissioning and Final Commissioning

19.2 Pre-Commissioning

The progress and /or completion of the pre-commissioning activities shall be recorded and reported by means of a site report to a format acceptable to the client.

19.3 Final Commissioning

19.3.1 The progress and /or completion of the Final commissioning activities shall be recorded and reported by means of a site report to a format acceptable to the client.

19.3.2 Site reports shall be completed for all stage of commissioning. Details of any problems, failures etc. must be recorded together with actions required and taken. Copies of site reports in a format to be agreed with the client shall be provided at the completion of the commissioning of each outstation for inspection by the client and shall be reproduced in the record documentation.

19.3.3 A back up should be made available by the vendor, which shall be used to re-install the system in case of system failure or malfunctioning. The vendor shall demonstrate the same by deleting the total software from the computers, load it from back-up and make it work.

19.3.4 Standby System Testing

19.3.5 The BMS specialist shall attend during the site test trials for the inter-linking of the alarms to other systems like FA/DG and demonstrate his system functions as specified elsewhere:

20 Planned Maintenance System (PMS):

The Main User Terminal shall be capable of running a Planned Maintenance System concurrently with the BMS. Automatic data exchange between the systems shall allow plant hours run and breakdown alarms and conditional data to be fed directly to the PMS so that maintenance reports can be generated. The PMS shall incorporate the facilities listed in General details.

21 Miscellaneous

Accessories required for complete operation of the system, whether specifically mentioned in the BOQ or not.

22.0 Spares

22.1 Commissioning Spares : Shall be included in the offer

22.2 Mandatory Spares (for 2 yrs) : To be recommended by vendor

23.0 Drawings and Documentation

23.1 Submittal shall include the following but not limited to ;-

a) Schedule of Outstations or DDC
b) Schedule of I/O cards included in each outstation
c) System block diagram indicating all the outstations and terminals
d) Data sheets of field devices duly filled
e) Project completion chart
f) Schedule of Sensors and actuators.
g) List of maintenance spares
h) Catalogues of all the equipment proposed
i) General Details on system working
j) Interconnection details – Block Diagram
k) Bill of Material to suit the system supplied
l) Compliance sheet
m) Deviations if any.
n) Configuration of computers as required

23.2 Post-award Stage

23.2.1 Documents shall include the following but not limited to ;-

a) Catalogues of all the equipment proposed (Xerox copies not accepted)
b) General Details on system working
c) System software and the manual
d) Interconnection details – Block Diagram
e) Interconnection details of all the equipments
f) List of recommended spares
g) O&M and Commissioning manual – Along with despatch particulars
h) As built / As Erected drawings / termination charts

24.0 CONTROL WIRING

24.1 ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

24.1.1 The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

24.1.2 All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self threading screws shall not be used in the construction of control panels. Knockout holes of approved size and

number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. lamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.

Note : All panel enclosures shall be suitable for outdoor application (IP 54 protection) and UL listed.

24.2 CONDUITS AND WIRING

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Architect/Engineers Any modifications suggested by the Contractor shall be got approved by the Architect /Engineers before the actual laying of conduits is commenced.

24.3 CONDUITS/TRUNKER

Conduits and accessories shall conform to relevant Indian Standards. Rigid G.I. conduits of required dia shall be used as called for in the schedule of quantities. Joints between conduits and accessories shall be securely made. The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

24.4 CONNECTIONS

24.4.1 All jointing methods shall be subject to the approval of the Architect/Engineer. Separate conduits shall run for all power wiring.

24.4.2 The threads and sockets shall be free from grease and oil. Connections between conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be smooth to avoid damage to insulation of conductors while pulling them through the conduits.

24.5 BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

24.6 FIXING CONDUITS

The conduits, junction boxes, outlet boxes and controller boxes once installed in position, shall have their outlets properly plugged or covered so that water, mortar, insects or any other foreign matter does not enter into the conduit system. Surface

conduits shall be fixed by means of spacer bar saddles at intervals not more than 500 mm.

The saddles shall be 2 mm x 19 mm galvanised steel flat, properly treated, primered and painted, securely fixed to supports by means of nuts and bolts/rawl bolts and brass machines screws.

24.7 DRAWING OF CONDUCTORS

24.7.1 While drawing insulated wires/cable into the conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. No joint shall be allowed in case of breakage of any conductor. No joint shall be shaved off like length of the conductors. Insulation shall be shaved off like sharpening of a pencil and it shall not be removed by cutting it square to avoid depression/cutting of conducting material.

24.7.2 Strands of wires shall not be cut to accommodate & connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

24.7.3 No wire shall be drawn into any conduit until all work of any nature that may cause injury to wire is completed. Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. Where wires are connected to detectors, or panel, sufficient extra length of wires shall be provided to facilitate easy connections and maintenance.

24.7.4 Only licensed supervisors/wiremen shall be employed for cabling and other connected work. Only approved make of cables shall be used. The cables shall be brought to the site in original packing.

24.8 MODE OF MEASUREMENT

24.8.1 Signal Cable

The cabling running between DDC controller to the field devices shall be termed as signal cabling. This cabling along with conduits shall be payable on per I/O point basis.

24.8.2 Communication Cable / LAN Cable

The cabling running between the system integration units to the DDC controllers between DDC panels and between DD panels to supervisor controller and to control station shall be defined as communication cable. This cable along with conduits shall be payable on per controller basis.

24.8.3 Power Cable

The cable supplying power to each controller shall be termed as power cable. This cable will be payable on a per controller basis.

24.9 SIGNAL CABLING & COMMUNICATION CABLING

The signal cable shall be of the following specifications :

- Wire : Annealed Tinned Copper
- Size : 1.5 sq. mm, 7 strands
- No. of conductors : Two (One pair)
- Shielding shield. : Armoured Overall bled foil Aluminium polyester
- Jacket : Chrome PVC
- Nominal DCR : 17.6 ohm/km for conductor
  57.0 ohm/km for shield
- Nominal OD : 8.5 mm
- Nominal capacitance at 1 KHz : 130 pF/m between conductors
  180 pF/m between one conductor and other conductors connected to shield.
- Colour : Black and Red

24.10 COMMUNICATION CABLE

The communication cable shall be of the following specifications :

- Wire : Annealed Tinned Copper
- Size : Minimum 24 AWG stranded
- No. of conductors : Two pair (4 conductor)
- Shielding : Overall beld foil Aluminium polyster shield.
- Jacket : Chrome PVC
- Nominal DCR : 78.7 ohm/km for conductor
  55.8 ohm/km for shield
- Nominal OD : 5.64 mm

- Nominal capacitance at 1 KHz : 131 pF/m between conductors
  243 pF/m between one conductor and other conductors connected to shield.
- Colour : Black and Red, Black and White)

24.11 LOCAL AREA NETWORK CABLE

Depending on the type of LAN system being used by the contractor, standard, manufacturer's specification shall apply.

24.12 MISCELLANEOUS

24.12.1 The final connection to the equipment shall be through Flexible connection in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.

24.12.2 An isolator switch shall be provided on all control panels along with fuses.

24.12.3 The branch lines from the main panel to each equipment shall be separate and should not criss cross other lines.

24.12.4 The entire installation shall be tested as per Electricity rules and IS 732-1973 with amendments 1,2 and 3 prior to the commissioning of the plants and a suitable test report furnished by a competent and authorized person. Contractor himself at his own expenses will obtain the test report.

24.12.5 All exposed switchboards panels, conduits, hangers etc. shall be given 2 coats of suitable of approved color, when all work has been completed.

24.12.6 Tenderer shall furnish the make, model no., principals / sub-vendor for all the equipments and key components proposed. Detail regarding ISO accreditation / UL listing shall be furnished. Reference list of previous installations shall also be sent along with the offer.

TECHNICAL DATA SUBMITTAL

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme given in schedule of equipment and bill of quantities.

S.No.	Description	Unit	Condition of Services

A. CENTRAL CONTROL STATION EQUIPMENT

1. CENTRAL PROCESSING UNIT

1.1	Manufacturer	:
1.2	Country of Origin	:
1.3	Local Agent	:
1.4	Model	:
1.5	Processor	:
1.6	Minimum ROM (K Bytes)	:
1.7	RAM Capacity Installed	:
1.8	Ram Capacity Expandable	:
1.9	Hard Disk Capacity (M Bytes)	:
1.10	Floppy Disk Drive Capacity (M Bytes)	:
1.11	Dimension Overall (mm)	:

2. COLOUR GRAPHIC MONITOR

2.1	Manufacturer	:
2.2	Country of Origin	:
2.3	Local Agent	:
2.4	Type	:
2.5	Model	:
2.6	Screen Size	:
2.7	Resolution	:
2.8	Colours	:

3. KEYBOARD

3.1	Manufacturer	:
3.2	Country of Origin	:
3.3	Local Agent	:
3.4	Type	:
3.5	Model	:
3.6	No. of Keys	:

S.No.	Description	Unit	Condition of Services
4.	**MOUSE**		
4.1	Manufacturer	:	
4.2	Country of Origin	:	
4.3	Local Agent	:	
4.5	Type	:	
4.6	Model	:	
5.	**REPORT PRINTER**		
5.1	Manufacturer	:	
5.2	Country of Origin	:	
5.3	Local Agent	:	
5.4	Type	:	
5.5	Model	:	
5.6	Print Speed	:	
5.7	Number of Columns	:	
5.8	Paper Feed	:	
B.	**SENSORS CONTROLLERS, SENSORS & TRANSDUCERS**		
1.	**DDC CONTROLLER**		
1.1	Manufacturer	:	
1.2	Country of Origin	:	
1.3	Local Agent	:	
1.4	Model	:	
1.5	Micro Processor Model	:	
1.6	No. of Bits	:	
1.7	RAM Memory	:	
1.8	RAM Backup Battery	:	
1.9	Battery Backup (Hrs)	:	
1.10	Transmission Rate	:	
1.11	Peer Communication	:	
1.12	Alphanumeric LCD Display	:	
1.13	Enclosure Dimensions (mm)	:	
1.14	Weight (Kg)	:	
1.15	Power Supply	:	

S.No.	Description	Unit	Condition of Services
2.	**SYSTEM INTEGRATION UNITS**		
2.1	Manufacturer		:
2.2	Country of Origin		:
2.3	Model		:
2.4	Micro Processor Model		:
2.5	No. of Bits		:
2.6	RAM Memory		:
2.7	RAM Backup Battery		:
2.8	Battery Backup (Hrs)		:
2.9	Transmission Rate		:
2.10	Peer Communication		:
2.11	Alphanumeric LCD Display		:
2.12	Enclosure Dimensions		:
2.12	Weight (Kg)		:
2.13	Power Supply	:	
3.	**IMMERSION / DUCT TEMPERATURE SENSOR**		
3.1	Manufacturer		:
3.2	Country of Origin		:
3.3	Type		:
3.4	Model		:
3.5	Accuracy		:
3.6	Sensor Material	:	
3.7	Temperature Coefficient		:
3.8	Sensing Range		:
3.9	Accessories		:
3.10	Degree of protection (IP)		:
4.	**OUTSIDE TEMPERATURE SENSOR**		
4.1	Manufacturer		:
4.2	Country of Origin		:
4.3	Type		:
4.4	Model		:

S.No.	Description	Unit	Condition of Services
4.5	Accuracy	:	
4.6	Sensor Material	:	
4.7	Temperature Coefficient	:	
4.8	Sensing Range	:	
4.9	Accessories	:	
4.10	Degree of protection (IP)		
5.	**RELATIVE HUMIDITY SENSOR**		
5.1	Manufacturer	:	
5.2	Country of Origin	:	
5.3	Type	:	
5.4	Model	:	
5.5	Sensing Range	:	
5.6	Output Signal	:	
5.7	Accuracy	:	
5.8	Power Supply	:	
5.9	Dimensions (mm)	:	
5.10	Weight (Kg)	:	
5.11	Degree of Protection (IP)	:	
6.	**PRESSURE TRANSMITTER**		
6.1	Manufacturer	:	
6.2	Country of Origin	:	
6.3	Model	:	
6.4	Pressure Sensing Element	:	
6.5	Range	:	
6.6	Monitoring	:	
6.7	Enclosure	:	
6.8	Supply Voltage	:	
6.9	Output Signal	:	
6.10	Degree of Protection (IP)	:	

S.No.	Description	Unit	Condition of Services
7.0	**WATER FLOW SWITCHES**		
7.1	Manufacturer	:	
7.2	Country of Origin	:	
7.3	Type	:	
7.4	Model	:	
7.5	No. of Contacts	:	
7.6	Type of Contacts	:	
7.7	Connections	:	
7.8	Power Supply	:	
7.9	Degree of Protection (IP)	:	
8.0	**DIFFERENTIAL PRESSURE SWITCHES FOR PUMPS / BLOWER**		
8.1	Manufacturer	:	
8.2	Country of Origin	:	
8.3	Type	:	
8.4	Model	:	
8.5	Construction Material	:	
8.6	Dimensions (mm)	:	
8.7	Sensing Range	:	
8.8	Max. Static Pressure on one side	:	
8.9	No. of Contacts	:	
8.10	Type of Contacts	:	
8.11	Power Supply	:	
8.12	Degree of Protection (IP)	:	
9.0	**FLOW METERS**		
9.1	Manufacturer	:	
9.2	Country of Origin	:	
9.3	Type	:	
9.4	Model	:	
9.5	Dimensions (mm)	:	
9.6	Output Signal	:	
9.7	Accuracy	:	
9.8	Mounting Arrangement	:	

S.No.	Description	Unit	Condition of Services
9.9	Type of Flow Measuring Element	:	
9.10	Operating Voltage	:	
9.11	Degree of Protection (IP)	:	
10.0	**LEVEL SWITCHES**		
10.1	Manufacturer	:	
10.2	Country of Origin	:	
10.3	Type	:	
10.4	Model	:	
10.5	Dimensions (mm)	:	
10.6	Mounting	:	
10.7	Type of Switch	:	
10.8	Type of Contacts	:	
10.9	No. of Contacts	:	
10.10	Power Supply	:	
10.11	Degree of Protection (IP)	:	
C.	**CABLES**		
1.	SIGNAL CABLES		
1.1	Manufacturer	:	
1.2	Country of origin	:	
1.3	Type	:	
1.4	Characteristics	:	
2.	**COMMUNICATION CABLES**		
2.1	Manufacturer	:	
2.2	Country of origin	:	
2.3	Type	:	
2.4	Characteristics	:	

INTEGRATED ADDRESSABLE FIRE DETECTION
AND
VOICE EVACUATION SYSTEM

1.0 SITE CONDITIONS, SPECIAL CONDITIONS AND GENERAL DESCRIPTION

The Fire Alarm System supplier shall furnish and install a fully integrated Fire Detection cum Voice Evacuation system for Institute for Liver & Biliary Sciences Ph-II at Delhi.

It is proposed to have a single, unified and integrated Fire Alarm cum Voice Evacuation system to meet the Life Safety Standards defined in NFPA standards and NBC standards .

The Fire Alarm System shall consist of Smoke detectors, Heat Detectors, and combination detectors selected as per specific requirements of the area to be installed in, as well as various input / output modules.

It is proposed to have Fire Detection Panels distributed at various floors, in the LV shafts.

Distributed on the floors are also the Voice and Fire Fighter's Telephone command Centers, in direct peer-to-peer network with the Fire Alarm Panels.

Every Staricase shall be provided with a Fire Fighter's telephone station comprising of a Firefighters telephone and jack, and a cabinet to house the same securely.

Voice evacuation speakers to meet the sound pressure levels as decreed by NFPA 72, NFPA 101 shall be deployed in the entire complex. Exit sounders, which shall emit a distinct temporal sound signature to help occupant evacuate the floor shall be deployed at the Fire Exit Staircases.

Digital Voice amplifiers shall be deployed on floor levels as per the attached schematics.

Touch Screen Panels, which shall enable the Fire Fighters to have immediate first hand information of any fire scenario, along with the facility to display auxiliary information which shall be programmed to facilitate fire fighting, shal lbe deployed at the entrances to the individual sections of the building, as depicted in the Schematic.

In Conclusion, a Truly Peer to Peer network of intelligent nodes shall be deployed to ensure life safety of the occupant of the building, and shall be programmed to ensure the fastest detection and safe evacuation of the occupants.

The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.

The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system wide or in selected zones.

The system shall be support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.

Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

2.0 SCOPE OF WORK

A. A intelligent reporting, microprocessor controlled fire detection cum Voice Evacuation system shall be installed in accordance with the specifications and drawings.

   The basic system comprises of Main Addressable Intelligent fire alarm panels, Voice and Fire Fighters Telephone Command Systems, Network Repeaters,Touch Screen Displays, networked on a peer to peer network as the headend of the System.

   The Low side of the System shall comprise of the intitiating devices such as the smoke / Heat / Combination Sensors, Manual Pull Stations etc.

   Notification Applicances shall include Hooter cum Strobes, Speakers and Speaker cum Strobes, Flashers, Alarm Bells etc.

   All the above components shall be connected by interconnecting 2 twisted pair x 1.5 mm, MICC, Zero Halogen Low Smoke Armoured cable, for physical protection.

   The scope shall include laying of the cables described above, citing of the various components to the direction of the architects and consultants, networking and programming to achieve the desired functionality.

B. The system shall be designed such that each signaling line circuit (SLC) is limited to only 80% of its total capacity at initial installation.

1. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

2. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
3. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
4. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.
5. Notification Appliance Circuits (NAC) speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone which ever is greater.
6. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
7. Notification Appliance Circuits (NAC) speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
8. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.
9. Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone.
10. Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.
11. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B (Style Y), or two Class A (Style Z) circuits.
12. Digital amplifiers shall be capable of storing up to two minutes of digitally recorded audio messages and tones. The digital amplifiers shall also be capable of supervising the connection to the associated digital message generator, and upon loss of that connection shall be capable of one of the following system responses:

    a. The digital amplifier shall automatically broadcast the stored audio message.
    b. The digital amplifier shall switch to a mode where a local bus input on the digital amplifier will accept an input to initiate a broadcast of the stored message. This bus input shall be connected to a NAC on a local FACP for the purpose of providing an alternate means of initiating an emergency message during a communication fault condition.

c. Speaker circuits shall be either 25 VRMS or 70VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.
d. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Center and up to seven (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
e. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.
f. The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of at least 16 or 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.

C. Basic System Functional Operation

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

1. The System Alarm LED shall flash.
2. A local piezo electric signal in the control panel shall sound.
3. The 640-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
6. The audio portion of the system shall sound the proper audio signal (consisting of tone, voice, or tone and voice) to the appropriate zones

3.0 CODES AND STANDARDS

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

A. Underwriters Laboratories Inc. (UL) - USA:

No. 50	Cabinets and Boxes
No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications.
No. 521	Heat Detectors for Fire Protective
No. 228	Door Closers-Holders for Fire Protective Signaling Systems.
No. 464	Audible Signaling Appliances.
No. 38	Manually Actuated Signaling Boxes.
No. 346	Waterflow Indicators for Fire Protective Signaling Systems.
No. 1481	Power supplies for Fire Protective Signaling Systems.
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems.
No. 1971	Visual Notification Appliances.

NFPA CODE 70 (NEC)

NFPA 72 Fire Alarm Code

NFPA 101 Life Safety Code

B. National Building Code of India, 2005.

C. All requirements of the Authority Having Jurisdiction (AHJ).

3.1 APPROVALS

3.1.1 The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc

FM Factory Mutual

3.1.2 The Fire Alarm Control Panel and all transponders shall meet the modular listing requirements of Underwriters Laboratories, Inc.

3.1.3 Each sub-assembly, including all printed circuits, shall include the appropriate UL modular label.

3.1.4 This includes all printed circuit board assemblies, power supplies, and enclosure parts. Systems that do not include modular labels may require return to the factory for system upgrades, and are not acceptable.

4.0 PRODUCT / MATERIAL SPECIFICATIONS

4.1 General

This section of the specification includes the furnishing, installation, and connection of a microprocessor controlled, analog addressable, intelligent fire alarm equipment required to form a complete coordinated system ready for operation.

It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.

The panel shall further extend fire and fault outputs, and on line data of status of all compoenents, to the BMS for critical alarm monitoring, and it shall be possible to connect a interface card for open Protocol based (Commonly BACnet, Modbus or eqv.) output to enable a software level integration with the BMS System.

The Panel shall be with integral voice evacuation cum Fire Fighters telephone system to relay evacuation messages in case of a fire emergency.

Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Central Monitoring Stations (Fire Command Center Room) and designated personnel, and if required, in other buildings at the site via a multiplex communication network.

The system shall also support independent gas release circuits for activation of various Fire Suppression systems, as required.

The system shall include hardware, modules to facilitate cross zoning of specific sensors, abort release functions, time delay and inputs for pressure switch and 24V output for Output operations.

The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

The main panel is to be located in the BMS Room on the Lower Basement Floor. All the other panels shall be distributed throughout the building complex, and shall be of multiple loops to accommodate all the sensors and devices with the spare loop capacity of 20% on every loop.

All the sensors and devices are connected to floor panels and all output circuits are activated from the same.

The Hooters cum Strobes / Speaker Strobes (Refer layout plans) are located at strategic locations to ensure audible alarm and voice messages reach every corner of the floor.

The panel shall be capable to zone all the sensors and devices and shall be able to activate outputs against activation of zone.

Wherever Applicable, The sensors located in Server Room shall be programmed in 2 separate zones per room to facilitate cross zoning, time delay and output to Gas Release system Panel in these rooms.

The panels shall be supplied with UPS power 230V AC and shall have its in-built battery backup and battery charger for 24 hours of standby operation, and the system shall be able to function for 30 minutes in full Alarm Condition, even during a Power Failure.

4.2 Basic Performance:

- Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 6 (Class A) Signaling Line Circuits (SLC).

- Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

- Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.

- On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

- Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

The System Alarm LED shall flash.

A local piezo electric signal in the control panel shall sound.

The LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

The audio portion of the system shall sound the proper signal (tone or voice) to the appropriate zones.

The fire alarm system shall detect all changes in status of monitored points and shall initiate appropriate acts to alert/evacuate occupants, provide event annunciation and activate auxiliary controls as specified herein.

The system shall accept process and evaluate the following types of input signals:

- Automatic Fire Detectors
- Manual Alarms
- Supervisory (Tamper) Condition
- Trouble

The system shall store a record of alarm, supervisory and trouble events in non-volatile history file. This file shall contain the most recent 1000 events, with time and date of each event. It shall be possible to select the number of events to be viewed in the history file by date, so the entire file does not have to be downloaded. The history file shall remain intact in the event of a loss of AC and battery power.

The system shall be capable of being expanded and field reprogrammed at any time up to the predetermined maximum capacity of the system, without the requirement to return the operating system to the factory for program changes. All field programming shall be done by an authorized manufacturer's representative.

Intelligent, Analog and Addressable input devices shall receive power and communication protocol signals over a single pair of wires per channel (SLC) from the control unit.

Each channel (SLC) shall support Minimum of 125 analog and/or addressable devices.

Channels shall be field programmable for NFPA 72(1993) Style 4 and 6 operations, with capability for Style 7 when used with approved loop isolation units.

Photoelectric, Laser and Thermal detectors shall be of the Intelligent, analog addressable type, and shall provide dual level alarm and pre-alarm reporting. Pre-alarm shall serve as early warning of an impending alarm condition, and shall generate a trouble condition in the panel.

Each detector head shall incorporate a microprocessor which provides for distributed system intelligence. The micro shall provide full monitoring and control of the device with memory for storage of pre-set sensitivity levels and other detection device parameters. For security purposes and system integrity no mechanical addressing switches shall be allowed for field devices. All setting of device parameter shall be done electronically.

System Power shall be adequate to accommodate all connected addressable and analog input devices in alarm simultaneously and shall be capable of operating all connected addressable output relays while all addressable inputs are in alarm. Prior to owner / contractor acceptance of installed system, manufacturer or his representative shall demonstrate 100% system alarm status with no loss of performance.

Activation of any manual alarm station or any other approved alarm initiating device (excluding Automatic Fire Detectors which will be described later) shall immediately result in the following:

Display the alarm condition on the LCD Displays of all the Peer-to-Peer networked Panels, Network Repeaters and Slave Repeaters, Touch Screen Displays.

Visual alarm signals shall be provided as indicated on the plans.

System shall shutdown/redirect all HVAC system fans, dampers, etc.; close fire doors, recall elevators, etc., in accordance with the schedule provided and with appropriate local/national code.

Operation of the system alarm silence switch shall silence all alarm audible connected to the system, with the exception of circuits programmed for the non-silence waterflow feature. When properly configured, a silence command shall not extinguish visual alarm appliances. Circuits containing alarm visual circuits shall not be silenceble except upon system reset.

The system alarm LED and all other associated alarm displays shall remain illuminated until the alarm condition has been corrected and the panel has been reset.

A connected system printer (if supplied) shall record all the status changes that take place within the fire protection system, including alarm / trouble restoration. All status changes shall be logged.

The activation of an Automatic Fire Detector shall provide for all operations.

Alarm Verification per device in accordance with NFPA 72 - 1993 and UL 864.

Positive Alarm Sequence in accordance with NFPA 72 -1993 and UL 864.

Analog-Addressable smoke detectors shall be equipped with a Day/Night Sensitivity Mode which may be selected by either manual or automatic input.

Because certain smoke detector environments change from day (occupied) to night (unoccupied), a more sensitive or Night setting may be desirable. Adjustable sensitivity smoke detector values shall be distinctly identified in the system memory and by display.

Supervisory conditions shall cause a distinct annunciation at the panel. The system printer shall record supervisory events in a manner consistent for all status changes.

The fire alarm panel shall fully supervise its operation. The physical opening or cutting of the wiring to any initiation, alarm indicating, signaling line, or associated supervisory monitoring circuit shall cause distinct annunciation via the LCD display.

Analogue signals from detectors shall be processed in such a way as to discriminate, as far as possible, between sources of fire and false alarms, and shall identify detectors that are becoming dirty. As a minimum, multi-state indications, i.e. normal, fire, fault and pre-alarm warning, shall be provided for each detector.

It shall be possible to interrogate detectors to determine their analogue values and display these on the alphanumeric display of each control panel. There shall be the facility to display an individual detector's value separately as well as values of all detectors together.

It shall also be possible to set a value and display the addresses of all those detectors with values above that value.

The controlling software of the system shall be configured to group detectors and manual call points into zones.

Output signals, for example, to sounder circuits and interfaces, corresponding to individual device inputs and/or their related zones, shall be configurable in the controlling software of the system. They shall be freely assignable; i.e. each input shall be capable of being programmed to operate any, some, or all outputs.

It shall be possible to modify the configuration of zones and reconfigure the relationship between inputs and outputs. This shall be site programmable.

The system shall be immune to EMC-related interference. In particular, the Contractor shall take into account the use of VHF/UHF radio communication systems, mobile telephones, pagers and computers, and other electrical equipment used in the building.

The system shall be installed in accordance with the manufacturer's instructions. In particular, the Contractor shall take due note of, and shall comply with, the manufacturer's instructions on circuit design, minimum signal strengths, loadings and end-of-line terminations, where appropriate.

4.3 Wiring Arrangements

It shall be the responsibility of the Contractor to determine the number of loops and other circuits required for the system.

Where the system is distributed, the network linking the control panels shall be capable of being extended in the future to link to further compatible control panels. The capacity of the network shall be expandable by 25%

4.4 Circuit Design

Each detection loop shall originate and terminate at the control and indicating equipment.

The number of loops required for the system shall be determined on the basis of device capacity, total loop length and the area of coverage of each loop. The maximum area coverage per loop shall not exceed 10,000m².

Each loop shall incorporate a minimum of 25% spare device capacity for possible future use. The spare capacity shall relate to manual call points, detectors, sounder and beacons (where relevant) and loop interfaces in any combination.

All wiring shall be monitored for faults.

Loop wiring shall tolerate a single open-circuit fault without affecting any device on the same loop. Loop wiring shall also tolerate multiple open-circuit or short-circuit faults in one area, without affecting the devices in any other area or on any other loop or circuit.

Removal of a device from a loop shall not cause any remaining devices in the system to become inoperative.

It shall be possible to disable detectors on the system. The controlling software shall permit individual detector disablement and detector group disablement. As a minimum, a group shall correspond with the detectors in a particular zone. Group detector disablement shall not render manual call points in the same area inoperative.

Short-circuit isolators shall be provided at the beginning and end of each loop. Also, a single short circuit or open-circuit fault on an automatic fire detector circuit shall neither disable protection within an area of more than 2,000m², nor on more than one floor of the building plus a maximum of five devices (automatic detection, manual call points, sounders or a combination of these) on the floor immediately above and five devices on the floor immediately below that floor.

Where the system is distributed, the network between control panels shall be configured as a loop and shall be capable of tolerating a single open- or short-circuit without loss of communication between panels. It shall be a 'peer to peer' network that is not wholly dependent on a single, centralized processor or panel. In the event of failure of the network, each control panel on the network shall be capable of operating in a 'stand-alone' mode and thus generating fire alarm warnings in response to activation of a device connected to it.

4.5 False Alarms

Great care shall be taken, at the design stage, to minimize the likelihood of false alarms occurring in the new or modified system.

Devices shall be of types appropriate to the local environment. For example, optical smoke detectors shall not be installed in areas where there is likely to be steam or dust present. Also, manual call points shall be fitted with transparent hinged covers where there is the possibility of accidental operation, e.g. in kitchens or service areas.

4.6 SYSTEM COMPONENTS

4.6.1 System Architecture

The system shall have a centralized structure. The locations of control and indicating equipment shall be as shown on the Contract Drawings.

A centralized system has one set of control and indicating equipment in a single location in the building. (The control panel may also be connected to repeater or mimic panel(s) elsewhere in the building.) This means that all detection loop wiring, and separate sounders

wiring (if appropriate) will emanate from the centrally located control and indicating equipment. Centralized systems are suitable where the lengths of loop and sounder cables do not become excessive because of the size of the building.

4.6.2 Main Components

All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

4.6.3 CABLING

All fire alarm system wiring must be as specified here in.

Wiring shall be in accordance with local, state and national codes (NBC of India, IS 2189, NEC Article 760), other relevant standards and as recommended by the manufacturer of the fire alarm system and approved by Engineer-in-Charge. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 1.5 Sq. mm for initiating device circuits and signaling line circuits, for notification appliance circuits.

MICC CABLES:

1. The cable shall be MICC (Mineral Insulated copper Conductor) cable confirming to British standard (BS: 5839, BS: 6387, BS 8434 & BS: 60702) (Latest Edition)

2. The cable shall have opening voltage grade of 500V and the outer copper sheath should be of seamless technology to ensure zero moisture ingress during the process of manufacturing.

3. The cable shall withstand temperature minimum 950 degree C for 3 hours Fire rated as per BS: 6387

4. The cable shall be LSZH (Low Smoke Zero Halogen) CWZ type, LPCB approved. As per BS 8434, all three tests of C, W & Z category should be performed on one single sample of cable and in no way these 3 tests should be done on 3 different samples.

5. The cable should have a life expectancy in excess of 100 years.

6. The cables shall be connected to the various devices with proper termination kits/glands. Appropriate glands shall be provided where the cable enters the junction box.

7. Cables are to be supplied along with all accessories, crimped termination etc. Cable is to be laid by the Trained & Experienced personnel only.

8. The cable when running in outdoor area shall not be taken overhead. It shall be laid underground according to IS 1255-1983 (Latest Edition)

9. The successful bidder shall submit an authorization letter from manufacturer assuring their technical & after sales service support for the project. However, the quality of material will be the responsibility of OEM.

10. The manufacturer shall have proper sales office and well established service centre in India.

11. The manufacturer should have supplied similar type of cables in the government organizations and a performance certificate from the organization shall be submitted.

12. The manufacturer shall have adequate no. trained personnel, based in india, who are specialized for termination and installation of MICC cables, which is specialty of this cable.

13. The delivery of material at site should not take more than 3 months after approval/ confirmed order.

They shall also be treated as circuit integrity cables, since these are used in circuits that must be able to maintain their integrity during a fire.

All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

4.6.4 FIRE ALARM CONTROL PANEL OR NETWORK NODE

The main FACP Central Console shall be a suitable to accommodate required number of devises having 1 Loop as spare for detectors & devices as well. It shall contain a microprocessor based Central Processing Unit (CPU).

The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.

In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

- Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

- Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.

- Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

- Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system alarm LED shall flash.

- A local piezo-electric audible device in the control panel shall sound a distinctive signal.

- The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

- Printing and history storage equipment shall log and print the event information along with a time and date stamp.

- All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

The system trouble LED shall flash.

- A local piezo-electric audible device in the control panel shall sound a distinctive signal.

- The LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.

- Printing and history storage equipment shall log and print the event information along with a time and date stamp.

- All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system trouble LED shall flash.

- A local piezo-electric audible device in the control panel shall sound a distinctive signal.

- The LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.

- Printing and history storage equipment shall log and print the event information along with a time and date stamp.

- All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system security LED shall flash.

- A local piezo-electric audible device in the control panel shall sound a distinctive signal.

- The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

- Printing and history storage equipment shall log and print the event information along with a time and date stamp.

- All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system pre-alarm LED shall flash.

- A local piezo-electric audible device in the control panel shall sound a distinctive signal.

- The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

- Printing and history storage equipment shall log and print the event information along with a time and date stamp.

- All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

4.6.5 Operator Control

4.6.5.1 Acknowledge Switch:

a) Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.

b) Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

c) Signal Silence Switch:

Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully fielded programmable within the

confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

4.6.5.2 Drill Switch

Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4.6.5.3 System Reset Switch

Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

4.6.5.4 Lamp Test

The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

4.6.5.5 Scroll Display Keys

There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

4.5.5.6 Print Screen

Depression of the PRINT SCREEN switch shall send the information currently displayed on the display to the printer.

System Capacity and General Operation

1) The control panel shall be capable of expansion via up to 10 SLC modules. Each module shall support a maximum of 318 analog/addressable devices for a maximum system capacity of 3180 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices and shall support up to 96 panel circuits which may consist of either inputs or outputs.

2) The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support

graphic bit maps capable of displaying the company name and logo of either the owner or installing company.

3) All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

4) The FACP shall be able to provide the following software and hardware features:

    a) Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

    b) Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.

    c) Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

    d) Action: If programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.

    e) The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

    f) Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.

    g) NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72.

    h) Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

i) On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

j) History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.

k) Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.

l) The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.

m) Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function

n) Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

o) Two Wire Detection: The system shall support standard two wire detection devices specifically all models of System Sensor devices, Fenwal PDS-7125/7126 and CPD-7021, Hochiki model SLK-24F/24FH, Edwards 6250B/6270B and 6264B and Simplex models 2098-9201/9202 and 9576.

p) Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions

q) Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

r) Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates

dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

s) Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

t) Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre alarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunciators, releasing zones, spal zones, and trouble zones.

u) Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fir alarm type code shall activate an output with a fire alarm type code.

v) Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will resound the panel sounder.

w) Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

x) Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.

y) Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.

z) Tracking/Latching Duct (ion and photo): The system shall support both tracking and latching duct detectors either ion or photo types.

aa) ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

bb) NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

cc) Security Monitor Points: The system shall provide means to monitor any point as a type security.

dd) One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

ee) Control by Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel

circuit module shall support listing of up to 10 zones into its programmed zone map.

ff) Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

gg) 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

hh) 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

ii) 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

jj) Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

kk) Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zones with four abort options to satisfy any local jurisdiction requirements.

ll) Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification.

When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

Central Processing Unit

1) The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.

2) The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

3) The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.

4) The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

5) Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.

6) Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.

7) The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.

8) The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.

9) The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.

10) The CPU shall provide one high-speed serial connection for support of network communication modules.

11) The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

Display

1) The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.

2) The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.

3) The system display shall provide a backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.

4) The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

5) The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 2 X 40-character LCD.

Loop (Signaling Line Circuit) Control Module

1) The Loop Control Module shall monitor and control a minimum of 250 intelligent addressable devices. This includes 125 intelligent detectors (Ionization, Photoelectric, or Thermal) and 125 monitor or control modules.

2) The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

3) The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class B) circuit.

4) The SLC interface board shall be able to drive an NFPA Style 6 twisted shielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit up to 3,000 feet in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.

5) The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

Enclosures

1) The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

2) The back box and door shall be constructed of 0.060 steel with provisions for electrical cables connections into the sides and top.

3) The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.

4) The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

Digital Voice Command Center

1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.

2. Function: The Voice Command Center equipment shall perform the following functions:

    a. Operate as a supervised multi-channel emergency voice communication system.
    b. Operate as a two-way emergency telephone system control center.
    c. Audibly and visually annunciate the active or trouble condition of every

speaker circuit and emergency telephone circuit.

d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
e. Provide all-call Emergency Paging activities through activation of a single control switch.
f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.
i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.
j. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

Power Supply:

1. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.
4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Addressable Main Power Supply shall be power-limited per UL864 requirements.

Auxiliary Field Power Supply - Addressable

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.

2. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.
3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.
4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.
7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.
9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.
10. The addressable power supply mounts in either the FACP backbox or it's own dedicated surface mounted backbox with cover.
11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.

14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

Field Charging Power Supply (FCPS)

The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.

1. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.
2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
3. The FCPS shall include an attractive surface mount backbox.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
5. The FCPS include power limited circuitry, per 1995 UL standards.

System Circuit Supervision

1. The FACP shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communication with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.
2. Transponders that lose communication with the CPU shall sound an audible trouble and light an LED indicating loss of communications.
3. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.
4. All speaker and emergency phone circuits shall be supervised for opens and shorts. Each transponder speaker and emergency phone circuit shall have an individual ON/OFF indication (green LED).

Field Wiring Terminal Blocks

1. All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

Audio Amplifiers

1. The Audio Amplifiers will provide Audio Power (@25 Volts RMS) for distribution to speaker circuits.
   2. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
   3. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:

      - Earth Fault on DAP A (Digital Audio Port A)
      - Earth Fault on DAP B (Digital Audio Port B)
      - Audio Amplifier Failure Detected Trouble
      - Active Alarm Bus input
      - Audio Detected on Aux Input A
      - Audio Detected on Aux Input B
      - Audio Detected on Firefighter's Telephone Riser
      - Receiving Audio from digital audio riser
      - Short circuit on speaker circuit 1
      - Short circuit on speaker circuit 2
      - Short circuit on speaker circuit 3
      - Short circuit on speaker circuit 4
      - Data Transmitted on DAP A
      - Data Received on DAP A
      - Data Transmitted on DAP B
      - Data Received on DAP B
      - Board failure
      - Active fiber optic media connection on port A (fiber optic media applications)
      - Active fiber optic media connection on port B (fiber optic media applications)
      - Power supply Earth Fault
      - Power supply 5V present
      - Power supply conditions - Brownout, High Battery, Low Battery, Charger Trouble

   The audio amplifier shall provide the following built-in controls:

      - Amplifier Address Selection Switches
      - Signal Silence of communication loss annunciation Reset
      - Level adjustment for background music
      - Enable/Disable for Earth Fault detection on DAP A
      - Enable/Disable for Earth Fault detection on DAP A

- Switch for 2-wire/4-wire FFT riser

5. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
6. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
7. System shall be capable of backing up digital amplifiers.

Audio Message Generator (Prerecorded Voice)/Speaker Control:

1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
3. A built-in microphone shall be provided to allow paging through speaker circuits.
4. System paging from emergency telephone circuits shall be supported.
5. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:

   LED Indicators:
   - Lamp Test
   - Trouble
   - Off-Line Trouble
   - Microphone Trouble
   - Phone Trouble
   - Busy/Wait
   - Page Inhibited
   - Pre/Post Announcement Tone

Controls with associated LED Indicators:

1. Speaker Switches/Indicators

   a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
   b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

2. Emergency Two-Way Telephone Control Switches/Indicators

   a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.

b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

Remote Transmissions:

1. Provide local energy or polarity reversal or trip circuits as required.
2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.
3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

System Expansion

Design the main FACP and transponders so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.

Field Programming

1) The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.

2) It shall be possible to program through the standard FACP keyboard all system functions.

3) All field defined programs shall be stored in non-volatile memory.

4) Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.

5) The system programming shall be "backed" up on a 3.5" floppy diskette utilizing an upload/download program. This system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

Specific System Operations

1) Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.

2) Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn-on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

3) System Point Operations -

Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.

4) System output points shall be capable of being turned on or off from the system keypad or the video terminal.

5) Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

. Device Status.
Device Type.
Custom Device Label.
Software Zone Label.
Device Zone Assignments.
Analog Detector Sensitivity.
. All Program Parameters.

System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:

System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.

The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

Addressable Devices

1) Addressable devices shall provide an address-setting means using rotary decimal switches / Soft Programming.
2) Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches.
3) Detectors shall be Analog and Addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.
4) Addressable smoke and thermal detectors shall provide dual (2)status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.
5) The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time-of-day basis.
6) Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7) The detectors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature.

The following bases and auxiliary functions shall be available :

Sounder base rated at 85 DBA minimum.

FORM-C Relay base rated 30VDC, 2.0A

Isolator base
The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

Addressable Pull Box (manual station)

1) Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

2) All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

3) Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

Intelligent Photoelectric Smoke Detector

The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

The detector **SHALL NOT** respond to refrigerant gas.

Intelligent Self Acclimatising Multi Sensor Detector

The intelligent multi sensor detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot

obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

The detector **SHALL NOT** respond to refrigerant gas.

Intelligent Thermal Detectors

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

Addressable Dry Contact Monitor Module

1) Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

2) The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.

3) The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

4) For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

Addressable Control Module

1) Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.

2) The control module shall mount in a standard 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box, or to a surface mounted back box.

3) The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

4) Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.

5) The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

Isolator Module

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

The isolator module shall mount in a standard 4-inch (101.6 mm) deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

LCD Alphanumeric Display Annunciator:

The alphanumeric display annunciator shall be a supervised, back-lit LCD display containing a minimum of 160 characters for alarm annunciation in clear English text.

The LCD annunciator shall display all alarm and trouble conditions in the system.

Up to 32 LCD annunciators may be connected to an EIA 485 interface. LCD annunciators shall not reduce the annunciation or point capacity of the system. Each LCD shall include vital system wide functions such as, System Acknowledge, Silence and Reset.

LCD display annunciators shall mimic the main control panel displays and shall not require special programming.

The LCD annunciator shall have switches which may be programmed for System control such as, Global Acknowledge, Global Signal Silence and Global System Reset. These switch inputs shall be capable of being disabled permanently or by a key lockout function on the front plate.

Serially Connected Annunciator Requirements

1. The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi-drop) two-wire communications loop. The system shall support two 6,000 ft. EIA-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,072 points of annunciation.
2. An EIA-485 repeater shall be available to extend the EIA-485 wire distance in 3,000 ft. increments. An optional version shall allow the EIA-485 circuit to be transmitted over Fiber optics. The repeater shall be UL864 approved.
3. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life programmable color LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.
4. The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.
5. Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.
6. An optional module shall be available to utilize annunciator points to drive EIA-485 driven relays. This shall extend the system point capacity by 3,072 remote contacts.
7. The LED annunciator shall offer an interface to a graphic style annunciator and

provide each of the features listed above

Battery

1) Shall be 12 volt, Lead Acid Maintenance free type.

2) Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 30 minutes of alarm upon a normal AC power failure.

3) The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

Battery Charger

1) Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 240-volt 50/60 hertz source.

2) Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.

3) Shall have protection to prevent discharge through the charger.

4) Shall have protection for overloads and short circuits on both AC and DC sides.

Speakers:

1. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.5 to 2.0 Watts.
2. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).
3. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
4. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

Audible/Visual Combination Devices:

1. Shall meet the applicable requirements of Section A listed above for audibility.
2. Shall meet the requirements of Section B listed above for visibility.

Programmable Electronic Sounders:

1. Electronic sounders shall operate on 24 VDC nominal.

2. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
3. Shall be flush or surface mounted as shown on plans.

Strobe lights :-

shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

1. The maximum pulse duration shall be 2/10 of one second
2. Strobe intensity shall meet the requirements of UL 1971.
3. The flash rate shall meet the requirements of UL 1971.

Alphanumeric LCD Type Annunciator:

1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.
5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a keyswitch or password.
8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

Fixed Emergency Telephone Handset

1. The telephone cabinet shall be painted red and clearly labeled as "Emergency Telephone." The cabinets shall be located where shown on drawings.
2. The handset cradle shall have a switch connection so that lifting the handset off of the cradle shall send a signal to the fire command center, which shall audibly and visually indicate its on-line (off-hook) condition.
3. On activating the remote phone, the phone earpiece shall sound a telephone ring signal until the master handset is lifted.
4. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.

Interactive Touch Screen Display :

This specification includes the furnishing, installation, connection, and testing of an interactive firefighters' display; including Underwriters Laboratories (UL) listed application software and hardware complete and ready for operation.

The basic system shall be Underwriters Laboratories (UL) listed for :No. 864 Control Units or Fire Protective Signaling Systems (Ancillary listing)

An interactive firefighters' display shall be installed in accordance to the project specifications and drawings. The interactive firefighters' display system shall include, but not be limited to, a touch screen interface, network communications media, power supplies, and wire / fiber optic media as shown on the drawings and specified herein.

The interactive firefighters' display shall support fire alarm, supervisory, and security events from the fire alarm control panel(s). The interface shall display building floor plans with respective active fire alarm devices, water supplies, evacuation routes, access routes, gas, power and HVAC shutoffs, chemical hazards, and structural hazards in the building.

The system shall include an easy one-touch method of viewing building, emergency contacts, the facility site plan, and active event information.

A supervised interface to fire alarm control panels and network shall be made available. The system shall be electrically supervised and monitor the integrity of all conductors.

Fire Fighter's Display : Performance requirements

A. The network will interface and report the individually monitored system's alarm status via a user-friendly Graphical User Interface (GUI) based software.

B. The software shall operate under Microsoft® Windows® XP Embedded platform as manufactured by Microsoft Corporation.

C. The GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations.

D. The software shall use a 1280 pixel x 1024 pixel GUI display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.

E. The software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.

F. The fire alarm device icon shall be visible only when it is in an alarm (or active)

condition.

G. The software shall display the activated smoke detectors in a time sequence to track smoke progression.

H. The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

I. The software shall provide a intuitive and easy way to navigate to different screens representing floors and areas within a facility.

J. The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.

K. The software shall display "YOU ARE HERE" along with icons representing standard building objects (stairs, elevators, etc) to be shown on the floor plan.

L. The software shall allow icons that represent hazardous materials stored in a facility.

M. The software shall provide a screen that displays preprogrammed building contact information.

N. The software shall provide a screen the displays building occupancy and other general building information.

O. The software shall allow a site plan to be imported that shows an aerial view of the facility.

P. The software shall display all active fire, supervisory, and security events within an event list.

Q. The system shall operate on an UL listed Embedded platform operating at no less than 700 MHz on the Microsoft® Windows® XP Embedded platform.

R. The Embedded platform shall have: no less than 256 megabytes of RAM, a flash drive with no less than 1 Gigabytes of storage space, 100 Base-T Ethernet NIC card, and USB ports.

S. The Embedded platform shall have a minimum 19" touchscreen display.

T. The Embedded platform shall come equipped with all necessary gateway modules to allow connection to the network it monitors as standard equipment.

U. A UL listed Ethernet Hub shall be provided for connection of multiple interactive displays and/or gateways.

MONITORING NETWORK

A. The monitoring network shall consist of a network based on proven ARCNET® technology.

B. The network shall have the ability to use fiber optic cable (single-mode and multi-mode), wire (twisted pair copper media in a style 4 or style 7 configuration), or combination wire/fiber communications with support of up to 103 nodes.

1. Wire networks shall support 12 AWG, 1 Pair Shielded to 24 AWG, 4 Pair Unshielded following the manufacturer's guidelines.
2. Fiber optic networks shall support 62.5/125µm cable 8dB limit (50/125µm cable 4.2dB limit)
3. Wire to fiber conversions using repeaters

C. High-speed data communications (312,500 BPS).

D. True peer-to-peer communications between fire alarm control panels.

PC Based Graphical Station for Central Monitoring :-

This specification includes the furnishing, installation, connection, and testing of a PC based graphical facilities monitoring system; including Underwriters Laboratories (UL) listed application software and hardware complete and ready for operation.

The basic system shall be Underwriters Laboratories (UL) listed for Standard 864 Control Units for Fire Protective Signaling Systems (9th edition)

The system shall comply with requirements of NFPA Standard No. 72 for Proprietary signaling System Receiving Unit except as modified and supplemented by this specification.

The PC based graphical facilities monitoring system shall be installed in accordance to the project specifications and drawings.

The PC based graphical facilities monitoring system shall include, but not be limited to, one or more PC based graphical workstations, all input/output devices, network communications media, control equipment, auxiliary control devices, power supplies, and wire / fiber optic media as shown on the drawings and specified herein.

A supervised interface to fire alarm control panels and networks shall be made available.The system shall include an interface to digital alarm communicator receivers for wide area network monitoring.

The system shall allow a mixture of different technologies and manufacturers' equipment to operate on the same network and provide the operator with a consistent look and operation for all monitored equipment.

The system shall support a variety of topologies and media and shall provide an industry standard open architecture transport layer protocol.

Using standard RS 232 ports on existing and future monitoring and control systems used by the facility, the system shall connect to and interpret status change data transmitted from the ports and provide graphic annunciation, control, history logging and reporting as specified herein.

The system shall be electrically supervised and monitor the integrity of all conductors.

Graphical Workstation Performance Requirements

A. The network will interface and report the individually monitored system's status via a user-friendly Graphical User Interface (GUI) based software workstation.

B. The software shall operate under Microsoft® Windows® XP Professional as manufactured by Microsoft Corporation.

C. The GUI based software must be capable of graphically representing each facility being monitored with floor plans and icons depicting the actual locations of the various systems; and / or sensors' locations.

D. The software shall use a 1024 X 768 GUI display capable of showing a large primary floor plan display, a key map representative of a larger view of the primary display and its relationship to the facility being monitored, the current operator, number of fire, supervisory, pre-alarms, troubles, and security events within the network as well as outstanding events and acknowledged events.

E. The workstation shall have the ability to support graphic printing of all data including graphical floor plans, system activity, history, and guidance text. A Windows compatible printer shall be supported for the graphics and report printer options.

F. The workstation software shall permit automatic navigation to the screen containing an icon that represents the system or sensor in the event of an off-normal condition.

G. The system/sensor icon shall indicate the type of off-normal condition and shall flash and change to the color associated with the off-normal condition (e.g., RED for ALARM and YELLOW for TROUBLE).

H. The software shall allow the attachment of text (TXT) files, sound (WAV) files, image (BMP) files and video (AVI) files to each system or sensor icon allowing additional information to be provided to the system operator for responding to the off-normal condition.

I. The software shall allow the importation of externally developed floor plans in

Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

J. The software shall provide auto-navigation to the screen containing the icon of any system or sensor when an event is initially annunciated. In addition, operator navigation to screens containing outstanding events shall be accomplished by "clicking on" the event from either the acknowledged or unacknowledged event.

K. History Manager. The software shall contain a History Manager, which shall record all system events with a time and date stamp as well as the current system operator's name.

1. The system shall provide for the ability to store all off-normal events experienced by the various sub-systems that are monitored by the system.
2. All events shall be recorded with a time and date stamp and the system operator shall be provided with the ability to log a pre-defined response or a custom comment for each off-normal event and have that comment stored in the history file with the time, date and operator name.
3. Provide for the ability to conduct searches and generate subsequent reports, based on all events for a single system / device address, a specific node, a specific type of off-normal condition and date range (mm/dd/yy to mm/dd/yy) or combinations of these search parameters. The number of entries in the history file that match the determined search criteria will be displayed.
4. The History Manager shall signal a need to back-up the history file at 100,000 events and then remind the operator at intervals of 100 events thereafter.
5. It shall be possible to pre-select data fields for reporting and then saving the report as a template with a file name. It shall also be possible to schedule the pre-defined report to print at a designated time.

L. Alarm Monitoring. The system shall provide for continuous monitoring of all off-normal conditions regardless of the current activity displayed on the screen.

1. If an operator is viewing the history of a sub-system and an alarm condition should occur, the system shall automatically navigate to the graphic screen showing the area where the off-normal event is occurring.
2. The system shall prioritize all off-normal events as defined by Underwriter's Laboratories into the following categories: fire alarms, troubles, supervisory alarms, pre-alarms and security alarms.
3. The system shall display a running count of all events by type in an alarm event counter window. The event counter window shall include five counters, defaulted to Alarm, Trouble, Security, and Supervisory events.
4. The system shall show a running list of all unacknowledged events and acknowledged events and allow the system operator to acknowledge an event by "double-clicking" on that event in the Unacknowledged Events box. The Unacknowledged and Acknowledged Events boxes shall contain an abbreviated description of the off-normal condition.
5. The details of the condition may be viewed by selecting event in the

unacknowledged events box.

6. The system shall allow the attachment of user-definable text files, image files and sound files, to each device / system monitored in order to facilitate the operators and response personnel's response to the off-normal condition.
7. The system shall record all events to the system's hard drive. A minimum of 100,000 events may be stored.

M. Reports & Logs:

1. The system shall provide for the ability to generate reports based on system history.
2. The system shall allow the system operator to enter custom comments up to 255 characters for each event and have those comments recorded in the system's history file.

N. Boolean Logic

1. An automated event response application shall be provided to automatically perform actions across the entire system based on network activity.
2. The event response application shall allow event responses (actions) based on predefined user conditions using simplified Boolean logic.
3. Actions shall be configured to be executed immediately or timed as required.

O. Control Aspects of System Software

1. The system shall provide for the direct control of all outputs associated with Input / Output dry contact relay points on Network Input/Output Nodes In addition, the system shall have the ability to control and program a sub-system through a terminal mode window (ASCII terminal type connection) interface to microprocessor-based sub-systems via an RS 232 serial Network Input/Output Nodes if available as an ancillary feature.
2. The system shall have the ability to monitor and control multiple control panels.
3. Discrete I/O Network Input/Output Nodes interfaces allow the system operator to initiate a change of state for the associated dry contacts.
4. A scheduling utility shall be included with the workstation to configure the I/O points on these Network Input/Output Nodes for automated activate/deactivate, and Arm/Disarm (depending on device type) status.
5. The workstation shall provide configuration utilities for monitoring and control profiles. These profiles shall be user definable for distribution of monitoring and control allowances for operators per workstation.
6. Terminal mode interfaces using serial Network Input/Output Nodes (if available for the specific system) shall be available to allow full programming and control of the system being monitored and shall provide the operator with the ability to take advantage of all features supported by a CRT attached to the associated individual sub-system.
7. Under no condition shall any sub-system be required to rely on the network for

any data processing required to perform its particular function. Each individual sub-system shall be in effect "stand-alone" as to insure it's continued operation should a disruption in communication with the system be experienced.

P. The software shall be password protected and provide for the definition of security profiles for operator access control.

Q. The software shall contain provision for defining monitoring profiles of pre-selected Network Input/Output Nodes for monitoring. This shall include provision for status types within the selected NODES.

R. The software shall contain provision for defining control profiles of pre-selected Network Input/Output Nodes for control.

1. The system administrator shall be provided means to select which signals can be controlled by selected Workstation.

S. The software shall support live voice paging for mass notification to evacuation system over Internet Protocol (IP).

Workstation for the PC Graphical Station :

A. The system shall be a Facilities Monitoring System.

B. The system shall operate on an IBM compatible UL listed Intel Pentium III processor operating at no less than 800 MHz on the Microsoft® Windows® XP Professional platform.

C. The workstation shall have: no less than 256 megabytes of RAM, a hard drive with no less than 20 Gigabytes of storage space, a minimum of 8 megabytes of video RAM, a CD-R/W for system backup, internal supervisory CPU watchdog board with audible annunciator, 100 Base-T Ethernet NIC card, a 104 key keyboard, and a mouse type pointing device.

D. The workstation shall come equipped with all necessary gateway modules to allow connection to the network it monitors as standard equipment. All workstations shall support Ethernet communications when multiple workstations are required.

E. The workstation shall support an SVGA monitor and be supplied with a 17" flat screen LCD monitor.

F. The computer shall be capable of networking to additional computers and these computers shall be capable of operating as workstations and/or gateways for local area or wide area networks.

G. Alarm annunciation shall appear on all workstations and may be silenced at each local workstation.

1. Only one workstation and operator shall be in command of the system for global alarm acknowledgement at any time.

Printer Support:

A. Support one or more Windows® compatible printers to be located and connected each workstation for graphics and report printing.

B. Support one model PRN-5 (or PRN-6), 80-column dot matrix tractor feed industrial grade printer for event and date-stamped printouts of off-normal events and status changes per workstation.

MONITORING NETWORK

A. The monitoring network shall consist of a network based on proven ARCNET® technology.

B. The network shall have the ability to use fiber optic cable (single-mode and multi-mode), wire (twisted pair copper media in a style 4 or style 7 configuration), or combination wire/fiber communications with support of up to 103 nodes.

1. Wire networks shall support 12 AWG, 1 Pair Shielded to 24 AWG, 4 Pair Unshielded following the manufacturer's guidelines.
2. Fiber optic networks shall support 62.5/125µm cable 8dB limit (50/125µm cable 4.2dB limit).
3. Wire to fiber conversions using repeaters.

C. High-speed data communications (312,500 BPS)

D. True peer-to-peer communications.

INTEGRATION NETWORK

A. The integration network shall be capable of monitoring a minimum of 100 nodes (Network Input/Output Nodes and routers) on an integration gateway consisting of, but not limited to:

1. Intelligent or conventional fire alarm control panels.
2. Competitor's intelligent or conventional fire alarm control panels.

B. Up to 99 gateways shall be connected via Ethernet for a total local area combination of up to 12672 (99x128) nodes.

C. Local area networks shall consist of a free topology network using twisted pair copper media in a bus, star, T-tap, or ring style 7 configurations at 78 Kilo baud. Transmit/receive twin fiber (multi-mode 62.5/125 µm) strand FT-10 point-to-point topology and bi-directional FO-10 networks shall also be available. Wide area

networks shall be supported by the use of network expansion routers.

1. Free topology (FT-10 style) wire network run allows multiple T-taps within a 1,500-foot (457.2 m) radius; 8,000 foot (2438.4 m) point-to-point using twisted pair; or 6,000-foot (1828.8 m) bus topology.
2. Free topology (FT-10 style) fiber network can also use fiber-optic cabling. Operates at 78.5 Kbaud.
3. Fiber optic (FO-10 style) network allows bus or ring topology using only fiber-optic cabling; node-to-node distance of over 10,000 feet (3048 m) with message regeneration. FO-10 style operates at 1250 Kbaud and utilizes multi-mode bi-directional fiber media (single fiber strand) in a bus or loop configuration.

D. Provide routers, repeaters or bridges where required to increase distance, alter network configuration or change media or to extend to remote facilities over alternate communications media including UL listed dial-up PSTN telephone, leased line, multimode fiber or Ethernet connectivity.

1. Dial-up units shall dial a local number and stay connected. Upon loss of carrier, a supervisory alarm shall be indicated at the workstation and the units shall automatically redial to connect.
2. Network expansion routers shall support public switched telephone circuits, two-wire or four-wire leased lines, and CAT5 Ethernet networks.

E. Network interface software shall be by the same manufacturer as the hardware portion of this specification.

F. The integration network shall utilize Network Input / Output Nodes to interface between the individual buildings' systems to be monitored by the integration network. The Network Input/Output Nodes shall act as a translator from the building system's specific panel communications protocol to the integration network protocol as well as serve as a transceiver from the building system panel to the integration network.

1. Network Input/Output Nodes shall be available in configurations that will allow transparent communications via RS 232 serial data ports with intelligent fire alarm control panels, security systems, and CCTV systems.
2. Network Input/Output Nodes shall be available in configurations that will allow monitoring of dry contacts, switched voltages, conventional security devices, access control panels and conventional fire alarm control panels using scheduled, automated and manual control.
3. Network Input/Output Nodes shall be UL listed to Standard 864 and 1076 and be provided with their own enclosure or be available in chassis mount configurations.
4. Network Input/Output Nodes shall operate at 24 VDC and obtain their power from the monitored control panel or a UL listed battery backed auxiliary power supply. All terminals shall be transient protected to 2400V and LEDs shall be

provided for status, service and diagnostics.

G. Digital Alarm Communicator Receiver Network

1. The system shall provide a digital alarm communicator receiver (DACR) gateway with a RS 232 interface to the following digital alarm communicator receivers for wide area event reporting: Ademco 685, Silent Knight 9500 and 9800, Radionics 6600.
2. Each gateway shall support up to 10 digital alarm communicator receivers for alarm and trouble information from reporting devices.

H. Workstation Network:

1. Computers shall be networked using Ethernet supporting the use of TCP/IP protocol for local area systems.
2. The network shall be capable of supporting multiple clients (e.g., workstations, configuration applications, automated response applications) and up to ninety-nine (99) gateways.
3. A UL listed Ethernet Hub shall be provided for connection of multiple workstations, gateways, clients, and/or network printers.
4. System shall be UL listed to communicate between clients and gateways over a business computer network (shared IP).

PC Graphical Station : System Setup & Conifuration :

A. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes.

B. The factory trained technician shall install initial data and artwork at each workstation including:

C. Distribution of monitoring, control and security profiles as requested by owner.

D. Area diagrams, floor plans, key maps and screen titles.

E. Auto-navigation criteria.

F. Guidance text as provided by owner.

6.0 SUBMITTALS AND DOCUMENTATION

Pre Commissioning

Prior to handover, the Contractor shall furnish with 'as fitted' drawings / wiring diagrams.

As fitted' drawings shall indicate the layout of all equipment, layout of aspirating smoke detector pipework, cable routes and cable sizes/types used. Wiring schematics, including cable termination details, shall also be provided by the Contractor.

'As fitted' CAD drawings shall be prepared using a software package capable of providing dwg format and two electronic copies shall be made available in that format. Also, four sets of A0 prints shall be provided to the Engineer.

Prior to handover, the Contractor shall also furnish GSI with O&M manuals. In addition to the manufacturer's technical data sheets on all components of the system and standard operating and maintenance instructions, the O&M manuals shall include specially written sections covering the specific operation of the system and any special maintenance requirements.

Three printed copies of the O&M manuals shall be supplied along with a copy in electronic form in a format that is computer readable, e.g. the Microsoft Office™ range of software i.e. Word™, Excel™, etc.

The following documentation shall also be provided at handover:

- The site-specific software as loaded into each control panel, to be supplied in both electronic format and printed listing for secure storage on site by GSI.
- Alarm audibility and/or intelligibility information. (This can be recorded on the 'as fitted' drawings.)
- Test results for all system wiring.
- Commissioning testing results/listings.
- Standby battery calculations.

Contract Documentation

The Fire Alarm contractor shall provide a complete set of documents describing the system and its design concepts, installation, final testing, commissioning, and required operating and maintenance procedures.

As a minimum, the following documentation shall be provided for the system:

1. System description.
2. Checklist of equipment and components.
3. Installation instructions.
4. Equipment connection diagrams showing wiring detail of Addressable Device positions with addresses.
5. Standby battery calculations showing system power requirements and formulas used to calculate specified power.
6 Final testing instructions.
7. Commissioning instructions.
8. Certification documents.
9. Log book.
10. System operating instructions.
11. Routine maintenance instructions and schedules.
12. Remote monitoring link description and operating instructions (if this option is being provided).

As a minimum, the following drawings shall be provided for the system:

1. System schematic diagram.
2. Cabling and wiring diagram.
3. Detailed equipment connection diagrams.
4. Building plan showing zoning and location of fire controller, detectors, call points, sounders and ancillary devices.

The Fire Alarm contractor shall provide a complete set of system operating and service manuals for the following:

1. Fire controller
2. Detectors
3. Call points
4. Sounders
5. Ancillary devices
6. Remote monitoring link (if this option is being provided).

The date for submission of all documentation shall be in accordance with the schedule provided by the Fire Alarm contractor and as agreed with the customer.

6.2 AS-BUILT DRAWINGS & OPERATING MANUALS

6.2.1 The Contractor shall submit As-Built drawings that have been reviewed and deemed satisfactory by the Engineer. Final submission shall include four (4) sets of A1 size, one set of A3 size and two sets of electronic copy (AutoCAD files) on CD-ROM disc.

6.2.2 The Contractor shall submit three (3) copies of an operating manual that have been reviewed and deemed satisfactory by the Engineer

The manual should include:

- General description of equipment and system.
- Operating instruction for all equipment and system.
- Schedule of equipment clearly stating the type, make, model, serial number, quantity, capacity, location and date of installation.
- Manufacturer's literature including catalogues, wiring diagrams, technical description, etc.
- Recommended frequency and detailed task list for routine maintenance for each system and equipment
- Final factory and site testing results for each equipment and each system with signatures of witnesses.
- Emergency contact lists for 24-hour, 365-days including duty and backup personnel.

6.5 CLOSE-OUT DOCUMENTS

1. Submit final copies of the shop drawings outlined as above. These final submittals shall reflect all field modifications and change orders required to complete the installation. Submit the following quantities of record submittal drawings immediately following receipt of notification of substantial completion. Auto CAD drawing or VISIO files of all shop drawings on or CD ROM disks.
2. Three complete sets of documents located in a Spiral Bound notebook and organized by subject with divider tabs.

6.6 CLOSEOUT MINIMUM REQUIREMENTS

The Life Safety Contractor shall ensure the following are completed at hand-over:

6.6.1 Any snagging to be documented and agreed date determined for clearance.

6.6.2 All passwords/PIN numbers, levels and operators recorded.

6.6.3 Disk copies of all system and data files supplied.

6.6.4 Proprietary software manuals & disks.

6.6.5 Consumables, printer ribbons, printer paper at agreed levels.

6.6.6. All equipment access keys handed over.

6.6.7 Complete sets of O&M manuals left with system, any agreed amendments/additions required to be documented and a target date for completion agreed.

6.6.8 Training of engineers and operators to be checked complete or program for completion agreed.

FINAL INSPECTION:

At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

INSTRUCTION:

Provide instruction as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

7.0 *QUALITY ASSURANCE*

7.1 GENERAL

7.1.1 The Life Safety System shall be furnished, engineered, and installed by Trained Engineers of the Contractor.

7.1.2 The contractor shall have extensive knowledge in the System Network Integration or shall be a factory trained and certified Integrator.

7.1.3 The contractor shall employ technicians who have completed the factory authorized training. The contractor shall employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

7.2 SYSTEM INTEGRATOR QUALIFICATIONS

7.2.1 The system integrator must be an authorized representative in good standing of the manufacturer of the proposed hardware and software components.

7.2.2 The system integrator shall have an office that is staffed with designers trained in integrating interoperable systems and technicians fully capable of providing LonWorks instruction and routine emergency maintenance service on all system components.

7.2.3 The system integrator shall have in house capabilities to provide control strategies for Life Safety Systems for the whole building control. This includes interfaces with HVAC, lighting, Access, Fire Detection,Fire Suppression and Protection, and security applications.

7.2.4 The system integrator shall have a service facility, staffed with qualified service personnel, capable of providing instructions and routine emergency maintenance service for networked control systems.

7.3 HARDWARE AND SOFTWARE COMPONENT MANUFACTURER QUALIFICATIONS

7.3.1 The manufacturer of the hardware and software components must be primarily engaged in the manufacture of Life Safety based systems as specified herein, and must have been so for a minimum of Ten(10) years.

7.3.2 The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel,

capable of providing instruction and technical support service for networked control systems.

7.3.3 The manufacturer & Bidder (if separate Entities) of the hardware and software components must have experience of no less than Six(6) similar projects, which have extensive hardwired and Software level integration with various building Utilities & building systems as 7.3.4 These projects must be on-line and functional such that the Client / Owners/Users representative should be able to visit such as installtion and observe the system in full operation, when demanded by the Client.

7.4 QUALITY ASSURANCE DURING EXECUTION

7.4.1 Physical Examination :-

A. Verify that systems are ready to receive work.

B. Beginning of installation means installer accepts existing conditions.

C. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

D. The contractor shall inspect the site to verify that equipment is installable as show, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

E. The Control System Contractor shall examine the drawings and specifications for other parts of the work, and if head room or space conditions appear inadequate or if any discrepancies occur between the plans and his work and the plans for the work of others, he shall report such discrepancies to the Architect/Engineer and shall obtain written instructions for any changes necessary to accommodate his work with the work of others.

7.5 FIELD QUALITY CONTROL

7.5.1 All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and National codes and ordinances as identified in Part 1 of this Section.

7.5.2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and/or wiring runs shall be installed parallel to building lines and properly supported.

7.5.3 Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

7.6 IDENTIFICATION OF HARDWARE AND WIRING

7.6.1 All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

7.6.2 Permanently label or code each point of field terminal strips to show the instrument or item served.

7.6.3 Identify control panels with minimum 1 inch letters on nameplates.Identify all other control components with permanent labels.

7.6.4 Identifiers shall match record documents.

7.6.5 Identify room sensors relating to terminal box or valves with nameplates.

8.0 GENERAL DESIGN FEATURES / PERFORMANCE CRITERIA

Refer Chapter 4 “Product Specifications”

9.0 DELIVERY, STORAGE AND HANDLING :-

9.1 CONTRACTOR'S RESPONBILITY

- It shall be the responsbility of the Contractor to ensure delivery of the equipment to the site free of any damages to the latter.
- Any Loading / Unloading Charges or incindental expenses thereof shall be borned by the Contractor for safe transit and storage of the equipment, and no further claim shall be made to the clien on this account.
- It shall be the responsibility of the Contractor to inward all material with proper emphasis on documentation and clearance from the Consultant / Client and project managers.
- Any Damaged Equipment supplied to the site shall be immediately replaced under notice to the client's project Supervisor / Manager at site.
- The Contractor shall provide for a safe and secure storage of the Equipment supplied under Lock and Key and shall indemnify the client against any on-site damage or theft of the Equipment, for which the contractr has relaised the monies form the Client.

9.2 PROTECTION

9.2.1 The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.
9.2.2 The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted.
9.2.3 The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site that is not immediately installed.
9.2.4 The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

9.3 CLEANING

9.3.1 This contractor shall clean up all debris resulting from his or her activities daily.
9.3.2 The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed.
9.3.3 Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.
9.3.4 At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dirt and debris, etc.

9.3.5 At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas.

9.3.6 Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

10.0 GENERAL INSTALLATION PROCEDURES AND REQUIREMENTS.

Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All cables, junction boxes, cables supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

Typical Operational Requirement:

Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

Activate all programmed speaker circuits.

Actuate all strobe units until the panel is reset.

Light the associated indicators corresponding to active speaker circuits.

Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.

Return all elevators to the primary or alternate floor of egress.

A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.
Smoke detectors in the elevator machine room or top of hoist way shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.

Correct installation, combined with the use of high quality equipment, components and cabling, ensures that the fire detection and alarm system shall operate as designed and provide many years of trouble-free service.

The Fire Alarm contractor shall install the alarm system in accordance with the documented installation instructions.

The Fire Alarm contractor shall provide all relevant installation documentation required for each component of the system.

Installation of the system shall be in accordance with the recommendations set out in NFPA-72

The Fire Alarm contractor shall be responsible for the correct setting of all equipment and components of the system in accordance with previously agreed plans and drawings.

All cabling and wiring shall be tested before they are connected to the fire controller and its associated devices.

WARNING If the tests are carried out after the cables and wires have been connected to the controller and its devices, components within the controller and the devices will be damaged by high voltages used during testing.

Materials

All cabling and wiring to be used in the system shall be copper Armoured with conductor not less than area 1.5mm² in cross section.

Wiring used for driving devices requiring high currents (e.g. bells, etc.) shall limit the voltage drop to less than 10% of the nominal operating voltage.

Cables used for the transmission of system data and alarm signals shall be in accordance with the types recommended by the manufacturer of the fire alarm system.

The ends of all cables shall be sealed by means of proprietary seals and associated glands. No heat shall be applied to any seal or termination. Cable tails shall be insulated by means of blank PVC sleeving anchored and sealed into the seal.

Where protection of the cable glands is required or terminations are on display, the glands shall be enclosed in red coloured shrouds of the appropriate British Standard colour.

All cables to brick/concrete shall be securely fixed by means of copper saddles sheathed with red PVC. These saddles shall be provided near bends and on straight runs at intervals no greater than recommended in the British Standards or by the manufacturer.

Where multiple cables are to be attached to a wall or soffit, copper saddles shall enclose all cables and shall be secured by means of suitable masonry plugs and two round head plated woodscrews

Where multiple cables are to be attached to the top of horizontal trays they shall be neatly run and securely fixed at suitable intervals. Copper or plastic cable fixings shall be used.

At detector and sounder locations, cables shall be terminated in approved galvanized junction boxes. All other devices forming part of the system shall utilize dedicated /custom back boxes.

Installation of Detectors

All detectors (and bases) shall be installed in accordance with guidelines set out in NFPA - 72 and the installation instructions provided by the manufacturer.

All detectors shall be installed in the exact locations specified in the design drawings; thus providing the best possible protection.

The type of detector installed in each particular location shall be the type specified in the design drawings.

All detector bases shall be securely fixed to approved boxes and allow for easy fitting and removal of detectors.

Cable and wire entries to detector bases shall be fitted with grommets to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at all entries to detector bases.

Cable entries of detector bases used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

Installation of Control Devices

All control devices (e.g. call points, sounders, interface modules, etc.) shall be installed in accordance with the guidelines set out in NFPA-72 and the installation instructions provided by the manufacturer.

All control devices and associated modules shall be installed in the exact locations specified in the design drawings.

The type of control device installed in each particular location shall be the type specified in the design drawings.

All control devices and associated modules shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

Cable and wire entries to all control devices and associated modules shall be fitted with grommets or glands so as to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at entries to control devices and associated modules as required.

Cable entries of control devices and associated modules used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

Installation of Fire Controller Equipment

The fire controller equipment shall be installed in accordance with the guidelines set out in NFPA-72 and the installation instructions provided by the manufacturer.

The fire controller and its associated component parts shall be installed in the location specified in the design drawings.

The type of fire controller and its associated component parts installed shall be the type specified in the design drawings.

The fire controller equipment shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

Cable and wire entries to the fire controller and associated devices shall be fitted with grommets or glands to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at entries to fire controller and associated devices as required.

The fire alarm system mains power connections to the fire controller equipment shall be accordance with the guidelines set out in the relevant British Standards and the installation instructions provided by the manufacturer.

The fire alarm system mains power isolating switch shall be coloured red and clearly labelled 'FIRE ALARM: DO NOT SWITCH OFF'.

Each circuit of the system shall be connected to the fire controller via associated fuse or circuit breaker devices located within the fire controller unit.

All cables from the fire controller equipment to the detection and alarm devices shall be clearly labelled as part of the fire detection and alarm system.

11.0 TESTING AND COMMISSIONING, TRAINING

Initial testing can be carried out as per following but not limiting to :-

Sr No	Description	Visual	Test Readings	Documentation
1	All cables are tested for continuty,insulation,resistance etc.			√
2	Carry out visual checks on all panels,cables,interphase modules etc.to ensure they are clean and free from any mechanical damage	√		
3	Check for proper termination & feruling	√		
4	Check input A/C supply voltage		√	
5	Check location/spacing of Detectors as per standards	√		
6	All device are addressed as per drawing		√	
7	Check Distribution of Detector / Loops / Zones as per Drawing.		√	
8	Check all Modules / Detectors, for healthy blinking status.	√		
9	Apply Smoke / Aerosol to random detectors & check output of the same in panel, shall display proper address/Loop/zone.Check for activation of approriate speaker circuits with message.		√	
10	Check distribution of Amplification Zones as per approved shop drawings		√	
11	Check tripping of AHU / Fan / Access doors etc. on activation of detectors.		√	
12	Activation of Hooter circuits as programme ,PA evacuation message/alert message/emergency message		√	
13	All the manual call point are working properly		√	
14	Hooter / Strobe are working as programmed		√	
15	If power fails, whether panel working on battery supply		√	
16	Panel display and all key working properly		√	
17	Check for seamless integration with BMS		√	

1. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

2. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

3. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

4. Verify activation of all flow switches.

5. Open initiating device circuits and verify that the trouble signal actuates.

6. Open signaling line circuits and verify that the trouble signal actuates.

7. Open and short notification appliance circuits and verify that trouble signal actuates.

8. Ground initiating device circuits and verify response of trouble signals.

9. Ground signaling line circuits and verify response of trouble signals.

10. Ground notification appliance circuits and verify response of trouble signals.

11. Check presence and audibility of tone at all alarm notification devices.

12. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.

13. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

14. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

COMMISSIONING

Pre Commissioning

At final commissioning of each system, the Contractor shall confirm that:

All detection devices, including point detectors, beam smoke detectors, flame detectors, and aspirating smoke detectors and inputs are tested and operate correctly.

All manual controls, whether manual call points or centrally located controls, operate correctly.

The correct indications are given at the control and indicating equipment, including the repeater panels, mimic panels and graphics PC central control and display terminal.

All outputs operate, in the required manner, including alarm sounders or voice alarm system loudspeakers, visual indicators and connections to ancillary services and other systems. In particular, the Contractor shall check that audibility levels of sounders and/or audibility and intelligibility of voice alarm broadcasts are correct.

The fire detection and fire alarm system complies with the operational sequence detailed in Section 5 of this Specification.

The standby batteries are adequately sized. (Measurements of the quiescent and alarm loads shall be taken and compared to calculated values used at the design stage.) Calculations and measurements shall be submitted to the Engineer.

Commissioning shall be fully documented and the documentation submitted to the Engineer.

The Contractor shall demonstrate each fire detection and fire alarm system to the satisfaction of the Engineer by conducting a series of witnessed acceptance tests as directed by the Engineer. This shall take place after the above final commissioning and following receipt of the commissioning documentation by the Engineer. Acceptance testing shall include the actuation of all devices in the system, simulation of various faults and operation of all manual controls.

Following commissioning, a system soak period of not less than one week shall follow, unless the system incorporates fewer than 50 automatic fire detectors, in which case no soak test is necessary.

Both the installation and the commissioning activities shall be undertaken as a single continuous operation.

Upon completion of the installation activity, the Fire Alarm contractor shall Test, Start-up, Commission and Handover the system to the customer.

The Fire Alarm contractor shall make use of the following documents to record test results and details of commissioning tests:

Cable Test Sheets
Installation Check Report
System Layout Drawing(s)

System Schematic Diagram(s)

The Fire Alarm contractor shall be responsible for inspecting and testing the complete system, including:

1. Detectors
2. Call Points
3. Sounders
4. Ancillary Devices
5. Fire Controller Equipment and Associated Devices
6. Auxiliary Equipment (e.g. Plant Interface Module, etc.)
7. Operating and Control Software.

The fire controller and associated devices and modules shall be tested in accordance with the guidelines set out in NFPA-72 and the testing instructions provider by the manufacturer.

The Fire Alarm contractor shall start up and operate the system for a trial period to ensure that it operates correctly.

The Fire Alarm contractor shall test all functions of the system, including the software, to ensure that it operates in accordance with the requirements of the design specification and relevant standards.

The Fire Alarm contractor shall undertake audibility tests during which the sounders may be operated continuously over a period of two hours. (Should the customer require these tests to be carried out at a separate visit, or out of normal working hours, this can be arranged at additional cost.)

Commissioning of the system shall constitute practical completion

Following the satisfactory completion of installation, testing and start up, the Fire Alarm contractor shall demonstrate to the customer that the system successfully performs all of the functions set out in the design specification.

The Fire Alarm contractor shall provide the customer with an agreed quantity of spare parts testing equipment and consumables which are to be used during routine maintenance and testing of the system.

The Fire Alarm contractor shall provide a customer appointed fire system supervisor with on-site training in the use, operation and maintenance of the system and explain the procedures to be followed in the event of fire and false alarms. The system supervisor shall also be shown how to carry out routine maintenance and testing procedures, and how to keep the Log Book. (also see Section 9).

The Fire Alarm contractor shall prepare a report detailing all tests performed during installation and commissioning of the system. The report shall include the results of the

tests and details of any specific settings or adjustments made. Any outstanding tasks or activities which are to be completed at another time shall also be included in the report.

The Fire Alarm contractor shall present an Acceptance Certificate for signature by the customer.

TRAINING OF OPERATING PERSONNEL:

- All training shall be by the Building Controls Contractor and shall utilize specified manuals, as-built documentation, and the on-line help utility.
- Operator training shall include four initial eight-hour sessions.
- The initial operator training program shall be to establish a basic understanding of Windows based software, functions, commands ETC.
- Special Emphasis shall be laid by the Trainer on imparting knowledge to the participants on extracting the maximum mileage out of the Head-end application to achieve energy monitoring and efficiency.
- Participants should be trained in the concept of maximum demand load management and the process logic applied by the IBMS system to achieve the same.
- The training shall encompass as a minimum:

    1. Troubleshooting of input devices, i.e., bad sensors.
    2. Sequence of operation review.
    3. Sign on - sign off.
    4. Selection of all displays and reports.
    5. Use of all dialogue boxes and menus.
    6. System initialization.
    7. GUI Software.
    8. Network Management Software.

12.0 INTERFACING WITH OTHER SERVICES.

- Interfacing with Third Party Service providers and Equipment Providers is a integral and most important part of the scope of works of the IBMS vendor.
- It shall be the Contractor's responsibility to study and inclulate the Design Logics of various Utilities being provided by third parties
- It is expected and assumed for granted that the Contractor shall study of third party drawings to locate equipment / locate Marshalling boxes to pick up signals relevant to Control and Monitoring of Life Safety
- The Contractor shall also prepare and share data related to software level integrations to the IBMS contractor on .net / xml / or conventional integration on MODBUS / LONWORKS / BACNET / DALI / M-BUS / JBUS / OPC Platforms, made availabe either on Serial interface or on a IP Platform.
- The Contractor shall be responsible to ensure that all information relevant to Interfacing with Other Services and Other Systems is collated an put to use to ensure a fully operational Life Safety System as per technical requirements put forth in the Tender, and to the descrition of the Architect / Client / Consultant as Directed from Time to Time.
- During Execution, it shall be Contractor's responsibility to follow Co-ordinated drawings and interface with other Services and contractors for proper laying and installtion of equipment such that there is no fouling of services in any manner.

13.0 MODE OF MEASUREMENTS

13.1 At various Logical Stages of the project, the Contractor shall ensure that joint measurements are taken, recorded and filed after the approval from the project managers / Consultants.

13.2 The contractor shall provide their own blank measurement sheets for the approval of the project managers /consultants to ensure confirmance to minimum information requirement on the subject document.

13.3 All Cabling Nodes for the Life Safety Systems – i.e., from the Notification Equipment to the Floor Fire Panels, and from Fire Panels to the Signalling Appliances shall be measured for SLC and NAC cabling. Communication cable between various network Nodes shall be measured separately at per meter basis.

13.4 Ethernet LAN Cabling from Equipment to Switches and Between Floor Switches to Main Network switch shall be measured as Networking Cabling at per meter basis.

13.5 Against the scheme and the Drawing plans, Equipment utilised and Spares shall be cross checked by the Consulting Engineer, the Contractor and the project manager as installed on site.

13.6 Equipment actually installed at site, against the individual line items shall be checked for confirmance, and joint measurement taken for Quantities, and then Certified.

14.0 OPERATION AND MAINTENANCE

14.1 The Contractor shall offer prices against the Operations and Maintenance contracts as asked for in the Tender.

14.2 Operations would mean manning the Life Safety System stations 24 x 7. This would entail the contractor providing for atleast 5 nos. or more of trained technical manpower of Diploma Engineer level on their payroll, present on the site at any given time. This team shall be responsible for smooth operation of the IBMS System, Reports generation, trend viewing, analysis and reports to the Facility Management team / Client.

14.3 It shall be the Contractors responsibility to provide their appointed Operations team to provide all tools, instrumentation and other accessories to enable them to fulfill the desired function.

14.4 The Client shall enter in to a Service level Agreement with the Contractor for the purpose of the Operations contract. Such a Agreement will list the response time to a client requirement and related parameters. The Agreement may also list a of events / alarms to the escalation matrix based on the response required for the event.

14.5 The Contractor shall provide the Replacement warranty for the components installed, while under the defects liablity period.

14.6 Under the DLP, the Contractos shall undertake all necessary maintenanace and repair / replacement actitivities to ensure 99.9% uptime of all the installed Equipment and the Life Safety system as a whole.

14.7 On the Completion of the DLP, the client may chose to enter in to a Comprehensive or non Comprehensive maintenance contract with the Life Safety Contractor for the purpose of regular planned and Emergency Maintenance of the system.

14.8 A Separate Maintenance Agreement and linked service parameters shall be defined in the SLA.

14.9 As a Minimum, whether under DLP or under Maintenance Contract post DLP, the expected reolution time shall be as follows :

- for minor complaints / maintenance issues : Max 4 Hours
- for Major Maintenance issues: Max 24 hours
- for Replacement of Level1 Importance components: Max 12 hours
- for Replacement of Level 2 Importance compoenents: Max 48 hours.

According to the recommendations in Codes, fire systems should be regularly maintained under a maintenance agreement.

Fire and planning authorities, and in certain cases insurers, have powers to check that fire systems are maintained. Failure to maintain the fire detection and alarm system could contribute to death or injury in the event of fire.

The customer shall be responsible for ensuring that daily, weekly and monthly routine maintenance is carried out in accordance with the recommendations set out in NFPA 72 and the service and maintenance instructions provided by the Fire Alarm contractor or manufacturer.

The Fire Alarm contractor shall provide detailed information about the maintenance services which can be provided after hand over of the system.

If requested, the Fire Alarm contractor shall prepare and submit a draft maintenance contract for consideration by the customer.

The draft contract shall include complete details of all materials and labour required to maintain the system in correct working order. It shall also include details of the testing procedures which will be carried out and specify the proposed number of visits per year.

SPARE PARTS PROPOSAL

15.1 It is expected that the Contractor advises the client the minimum spares that need to be stocked on site.

15.2 Further, the Contractor needs to Stock key components that may affect the working of the Life Safety system at his own premises without any additional cost implilcation to the client, and ensure the minimum reolution times as defined in 14.9; or as defined and agreed in the SLA are met with.

a) List of Parts recommended to be kept on site (the total price of this section shall be in line with the tender BOQ Requirement).

b) List of Parts expected to have planned replacement within the first 5 years of operation.

c) List of Parts that are normally kept in the Contractor's Delhi warehouse, for delivery to site within 12 hours.

d) List of Parts that would be required to be ordered/imported (including expected delivery times).

TECHNICAL SPECIFICATIONS FOR IP BASED CCTV SYSTEM

INTRODUCTION AND GENERAL SITE INFORMATION:-

This is a Hospital consisting of three major blocks,

1. Clinical block.
2. Vivarium Block.
3. Academic Block.

Building Consist of Common 2 Basement, Common 1 Ground, 1 to 3rd Floor is shared by the Clinical block & the Academic Block and Vivarium Block, from 4th to 5th it is shared by the Clinical block & the Academic Block only.

Security systems including CCTV Systems shall be deployed to ensure a foolproof security environment within and outside this iconic structure.

1.0 SPECIAL TECHNICAL CONDITIONS :

1.1 The Security Vendor shall supply and commission an IP Camera based DVSM system with the objective shall be to provide High degree of Video surveillance system to all the critical locations within the entire building premises.

The manufacturer & Bidder (if separate Entities) of the hardware and software components of the IP CCTV Surveillance System must have experience of no less than Three (3) similar projects in India or Abroad, with the Bidder executing at least 1 project of Minimum 400 IP Cameras on a Single Installation, and a Integrated IP CCTV Management Software, which has extensive hardwired and Software level integration with various other building Utilities & building systems.

1.2 The purpose is to monitor & supervise the entire area for security purposes, as well as the record and inform officials on unwanted, untoward incidents. It is also essential to have recorded images to be stored at least for 30 days of all critical area's to facilitate investigations of a reported case.

1.3 The Hardware required for the System including servers, workstations, monitors, networking components, cables, connectors, conduits, power supplies etc. will be in vendor's scope.

1.4 Should the Bidder need IT / Server or Networking hardware more than what is budgeted for and

provided for in the tender, then the Bidder needs to inform the tender committee / Consultants in writing on the same along with the Tender BID and include the same in his bid price.

1.5 Any additions to the Takeoff Quantities given in the tender, if required by the Bidder at the tender Stage will need to be spelt out by the Bidder at the time of the Bid itself.

1.6 In order to maintain the expected reliability levels of the offered system should compulsorily meet all the requirements of Failover Management application, Failover recording and Redundant recording requirements as described in detailed specifications.

1.7 All the perimeter security cameras must provide the Video analytics functionality in order to improve real time effectiveness of the system to handle the exceptional events.

1.8 Further, the Bidder is expected to study the floor plans, schematics and all relevant information provided in the tender document to arrive at the Scheme of deployment for the CCTV Security network.

1.9 Solution Overview

1.9.1 The present proposed system consist of approximately 500 IP cameras, required servers, storage, workstations, monitors, Video management software, analytics etc.

1.9.2 All these cameras should be connected to central Monitoring Station at BMS room through dedicated LAN network (dedicated for CCVT and Access control) with fibre backbone.

1.9.3 Telecom room should be equipped with servers and storage to record all the cameras with minimum of 30 days retention period. S

1.9.4 Storage calculation should be good enough for recording floor 1 to floor 5th fixed dome cameras at 640 x 480 @ 6FPS, Lift cameras with 4CIF @ 3FPS, whereas all other cameras on Ground floor, Basements, FOH, BOH and perimeter protection etc should be recorded at 4CIF @ 25FPS.

1.9.5 Servers and storage should be equipped with highest level of reliability by providing specified failover and redundant mechanisum.

1.9.6 Monitoring of all the cameras should be possible from BMS room.

1.9.7 BMS room should be equipped with 6 Nos. 40" Monitors, 6 Nos. 19" monitors, 2 Joystick controllers for five operator positions.

1.9.8 Each of the 40" monitor should ideally be configured to display 3x3 layouts (90 cameras simultaneously) so as to cover all the cameras in sequence.

1.9.9 2 of the 19" monitors should be configured to display quad layout so as to display 20 most important cameras across the premises without any sequencing.

1.9.10 Rest of the 3 monitors will be used by the operators for alarm monitoring and controlling of the system.

1.9.11 All though the system should provide the flexibility to display any content on any of the monitor as per situational requirements.

1.9.12 Apart from this, 3 nos. workstations with dual monitor facility should be provided which will be installed as per user requirement across the various critical monitoring points (i.e. Logistics control room, Main entrance gate etc)

All equipment and materials used shall be standard components that are regularly manufactured and used in the system.

All systems and components shall have been thoroughly tested and proven in actual use.

2.0 SCOPE OF WORKS

2.1 Scope of works include the provisioning of a fully functional IP Based CCTV system, complete end to end solution, including

2.1.1 Supply and Setting up a High speed, high bandwidth Fiber optic network for the CCTV System to the direction of the Consultant,

2.1.2 Supply of all related active and passive Network components for the Fiber Optic Network, including Servers and Switches, Convertors, Patch Cords etc.

2.1.3 Supply and Programming Intelligent DVM Software and Analytics to the directive of the consultants,

2.1.4 Supply, installation of Cameras as per Tender BOQ.

2.1.5 Supply of Auxiliary components such as Camera Mounts, Yard Poles to Mount Cameras, Network Racks, Power Supplies

2.2 Programming of the Software Features to meet the Security needs of the multiple use building.

2.3 Interfacing with other Systems such an Access Control, Gating Solutions, Elevator / Lift Management etc., to the directive of the Consultants.

2.4 Testing and Commissioning of the entire system.

2.5 Formal Handover after due diligence of the system performance.

2.6 Training of Operating Personnel and Documentation.

3.0 CODES AND STANDARDS

1) APPLICABLE STANDARDS

Original Equipment Manufacturer Standard

2) APPROVALS

A. UL Listed and
C. FCCB

4.0 PRODUCT / MATERIAL SPECIFICATIONS

- The product described in this specification is (IP) based Digital Video Management (DVSM) System.

- The proposed solution shall not require proprietary computer, server, and network or storage hardware.

- The proposed system shall be of a manufacturer with as minimum of five (5) years of experience and offerings in the IP network video software market, the letter stating the same should be submitted by the manufacturer.

- The DVSM database and video storage shall be based on SQL Server 2005 or better

    a) Synchronized Failover directory/application should be a basic feature of the DVSM all the related licenses should be included in offer.
    b) In case of failure of primary database application, failover directory should automatically takeover the system management.
    c) Synchronized Failover recording capabilities shall be a basic feature of the DVSM and should be included in offer.
    d) System design should consider minimum of 40% simultaneous failover capability.
    e) In case of more than 40% server failure simultaneously, system should takeover user pre-configured top priority 10% cameras among the array of failed server.
    f) Redundant recording capabilities shall be a basic feature of the DVSM and should be provided for user defined cameras.
    g) By this functionality most critical camera, if necessary, and as defined by the Client/ Consultant (i.e. Entry points, exit points, perimeter, etc) shall be necessarily recorded in a Redundant Mode.

- The DVSM system shall be based on the latest in software programming technology Microsoft. NET frame work.

- The DVSM approved IP cameras except outdoor PTZ shall provide the ability to be powered by power over Ethernet (PoE) 802.3af option.

- The DVSM shall be able to support all cameras at the up to 25 frames and full resolution as per camera specifications.

- **The DVSM should support any of the following Video Analytics Features on all perimeter fixed cameras and PTZ cameras.**

    a) Trip wire detection
    b) Illegal parking
    c) Loitering detection

d) Stolen object detection
e) Object left detection
f) Synchronous PTZ tracking (Handshake between fixed and PTZ)
g) Operator selected object tracking

- The DVSM video storage shall be capable of storing video for a period of 30 days available for on line access – the license provided with the Tender Offer shall be for unlimited storage capability.

- The DVSM Storage solution shall be as minimum set at RAID-6 configuration
  a) Storage system shall be of Direct Attached Storage (DAS) systems, or Network Attached Storage (NAS) systems and / or Storage Area Network (SAN) Systems as per the directive of the Consultant / Client.

- The DVSM shall be based on high quality Dual stream, H.264 & MPEG-4 IP cameras.

- JPEG, MJPEG, Wavelet, or any other image based video compression **will not be considered** as approved equal due to the high network bandwidth associated with these types of digital video compression.

- Each Camera shall provide dual video streaming technology providing independent settings per stream on the network.
  a) A viewing stream of up to 25 fps and 4CIF/VGA (as per detailed camera specifications) video resolution and a recording stream of up to 25fps and 4CIF/VGA video resolution as per relevant camera resolution.
  b) The DVSM shall allow the user to view live video at High resolution 4CIF while recording at a lower CIF or 2CIF or VGA for more efficient video storage.
  c) The system shall be flexible and allow bandwidth selection between 64Kb to 4Mb per stream.
  d) Total bandwidth for dual stream H.264, MPEG4 based cameras both stream shall not exceed 6MBps.
  e) When both the viewing stream and the recording stream are set at the same FPS and resolution the camera shall send on the network a single multicast stream this shall help reduce network bandwidth.

- The DVSM shall have a capacity to switch and control all the currently tendered cameras quantities. It should be expandable to unlimited cameras in future.

- The system shall allow the recording, live monitoring, playback of archived video audio, and data simultaneously

- The DVSM shall provide file export tool for export the native video format with all video protections (e.g. watermark, encryption) and the ability to play this video on a standard computer.

- The native file format video player shall show the status of the video authentication as available with the original file format.

- The IP Based DVSM shall provide file export tool for export of single frames of video in J-PEG and

BMP file formats and for export of motion video files in AVI file format for transport and playback on computers utilizing a Windows environment.

- The Client shall provide the required computers for the DVSM client and servers, these computers shall be of the most current state of the art technology available at the time of installation and as minimum shall be better than the minimum requirements specified by DVSM system manufacturer as well as tender specifications.

AA. DIGITAL VIDEO SURVEILLANCE AND MANAGEMENT SERVER SOFTWARE.

- The DVSM software shall consist of an MS-SQL 2005 or better based Main and failover Directory Database Server, Archive Server for audio and video, Failover recording, Digital Virtual Matrix, Incident Reports, Automated Scheduled backup, Alarm Management, reporting tolls and Watchdog modules. All the related software licenses should be the part of the offered system.

- The DVSM Server shall maintain a catalog of settings for all the client, servers, and IP cameras in the system
  a) The DVSM shall enable the client to dynamically create connections between any camera on the digital monitors (audio, video, serial ports and digital I/Os)
  b) The DVSM shall provide the client seamless operation of all cameras available in the system regardless of the actual connection to different archive servers.
  c) The DVSM shall detect signal loss and have the capability to alert the systems administrator

- The DVSM Archive Server shall offer the capability to be installed multiple servers software on multiple Computer Servers to enable distributed archiving architecture on the LAN or WAN.

- The DVSM Archive Server, for video and audio, shall support and manage (150) camera connections from IP cameras each at 25FPS PAL and 4CIF resolution (704x576PAL) and (180) cameras at 25FPS PAL and 2CIF resolution (352x288 PAL), 250 cameras at 25FPS and CIF resolution.

- The DVSM shall be able to set each camera frame rate, bit rate and resolution independently from other cameras in the system, and altering these settings shall not affect the recording and display settings of other cameras.

- The DVSM shall utilize multicast network communication for video monitoring.

- Unicast based equipment will not be considered as an approved equal for alternate system.

- The DVSM shall be a software based solution, and shall not require proprietary hardware for video and audio recording servers.

- The DVSM shall have a built-in Digital Video Matrix Switcher functionality without the need of any additional software license.

- The Virtual Matrix Switch shall provide a full matrix operation of IP video to digital (computer) screens or analog monitors using Decoders.

- The Virtual Matrix Switch shall have the capability of creating camera sequences with the following functionalities:

- The DVSM shall support web based clients connecting to the DVSM system via the Internet.

- The DVSM shall support a built-in Watchdog module.

- The Watchdog shall monitor operation of all services and automatically restart them if they are malfunctioning.

- The Watchdog shall be responsible for restarting the application or in a last resort restart the server in case of malfunction of software components.

- The DVSM shall be based on a true open architecture that allow for use of nonproprietary PC and storage hardware that shall not limit the storage capacity and shall allow for gradual upgrades of recording capacity.

- The DVSM Server shall be of the most recent computer technology and shall cover the DVSM requirements.

- To provide an advanced and reliable system the operating system shall be Windows 2008-Server level (Win 2003 server will not be considered as approved equal)/ Linux

- The DVSM shall provide alarm dry contact interfaces to allow for any alarm input initiating any action in the DVSM system.

- The DVSM shall transmit dry contact information over the IP Digital Transmission Network.

- The DVSM shall provide a serial interface for alarm input to allow for any alarm input initiating any action in the DVSM system.

- The DVSM shall transmit alarm serial information over the IP Digital Transmission Network.

- The DVSM Shall support full duplex audio communication and transmission signals over the IP Digital Transmission Network without the need of any additional license.

- The DVSM shall provide a reporting utility for tracking but not limited to the following options. Video and images shall be stored with reports for documenting events.
    a) Alarms, Incidents, Operator logs, Service requests
    b) The Email Alert should be generated in responds to alarms triggered in DVSM software and sends out email alerts to a preconfigured list of recipients.

c) It should be possible to export the settings of various entities within the DVSM i.e Archiver, Directory, cameras etc.. It should be possible to print these reports.

d) It should be possible to get reports on past events by querying the audit databases. It should allow the search by User Logon, Entity Configuration, Incident, Alarm, Application Failure, and Equipment Failure.

e) It should prove the tool to create the case document which should include Archive Video, Photos, Text and other file attachments.

- The DVSM shall provide alarm management module without the need of any additional license.

- The alarm management shall be able to set any monitor or groups of monitors to automatically display cameras in response to alarm inputs.

- The alarm management shall be able to reset automatically or manually alarmed video.

- The alarm management shall allow for multiple modes of alarm handling capability, these modes to be programmed within the same system.

- The DVSM shall have support a Internet Gateway server application without the need of any additional license
    a) The Internet Gateway server shall allow clients to view good quality video streams from remote locations, over the internet, over firewall and proxies
    b) The Internet Gateway server shall manipulate the video data to adjust the video stream type and properties to the connection type
    c) The Internet Gateway server shall support all video stream types, including live, archive, instant replay, video sequences, and video on alarm.
    d) The Internet Gateway server shall have only one TCP port exposed to the internet, thus masking the video servers, encoders and cameras from direct connections coming from external networks.
    e) The Internet Gateway server, in collaboration with the Gateway server, shall provide remote users full functionality in a transparent way; the remote user will use the system normally despite the fact that the connection goes through the Internet Gateway.

BB. *DVSM CLIENT*

- The DVSM client shall consist of Administrator Tool application, a Monitoring application, remote monitoring application and Smart phone application.

- The DVSM client shall perform the following applications simultaneously without interfering with any of the Archive Server operations (Recording, Alarms, etc.):
    a) Live display of cameras
    b) Play Live audio
    c) Broadcast audio to remote locations
    d) Live display of camera sequences
    e) Live display of stitched and/or panoramic camera views

f) Control of PTZ cameras
g) Playback of archived video and audio
h) Playback of stitched and/or panoramic camera clips
i) Retrieval of archived video and audio
j) Instant Replay of live video and audio
k) Instant Replay of stitched and/or panoramic camera clips
l) Use of graphical controls (maps)
m) Configuration of system settings
n) Execution of system macros.

- The DVSM client applications shall support any form of IP network connectivity, including: LAN, WAN, VPN, Internet, and Wireless

- The DVSM client applications shall support IP Multicast (UDP) and Uncast (UDP) video and audio streaming.

- The DVSM client applications shall automatically adapt to the network topology and use the best available method to receive streaming video.

- The DVSM client applications shall provide an authentication mechanism, which verifies the validity of the user.

DVSM Client Application:

- The Client Monitor application shall allow for live monitoring of video and audio.

- The Monitor shall enable view of 1 to 25 video tiles simultaneously on a single SVGA (1 024x768) monitor at 30fps per camera.

- The Monitor shall enable view of up to 25 video tiles simultaneously on a single monitor and shall provide the ability to connect up to four (4) monitors to a single computer supporting multiple SVGA (1 024x768) monitor outputs.
- The IP Based DVSM Shall provide as minimum on each of the VGA monitors independently the following tile views:
  - Full screen,
  - Quad,
  - 3x3,
  - 4x4,
  - 5x5,
  - 1 + 9 (One large and 9 small view),
  - 1+11 (One large and 11 small view),
  - 1+12 (One large center tile and 12 small view),
  - 1+15 (One large and 15 small view),
  - And more as per the directives of the Consultant

- The Client monitor shall enable playback of audio independently from video. The monitor shall

enable the user to work with multiple Audio layouts containing collections of microphones, speakers and audio clips.

- The DVMS shall allow use of Windows XP. Windows Vista and Windows 7 OS for client machines as we intend to access the video from existing machines which has these Operating systems and can not be changed.

- The Client monitor shall enable playback of audio mixed from both live and archived audio sources, allowing the user to control the volume of each source independently as well as mute them or record them manually.

- The Client monitor application shall enable broadcast of audio from the user workstation to multiple speaker or other audio out resources simultaneously. This shall be available using a simple microphone connected to the user workstations sound card.

- The DVSM Monitor application shall allow operators to view an instant replay of any camera or audio input (microphone).

- The operator shall be able to define the amount of time he wishes to go back from a predefine list or through a custom setup period.

- The operator shall be able to control the playback with play, pause, forward, and speed buttons.

- The DVSM Monitor application shall allow operators to add bookmarks to recorded clips of video or audio

- The operator shall be able to choose and trigger an action from a list of available actions included but are not limited to:-

    - i View camera in a video tile
    - ii View camera on a Decoder (analog monitor)
    - iii View Map or procedure in a video tile
    - iv Starting/stopping PTZ pattern
    - v Go to PTZ Preset
    - vi Sending alert messages
    - vii Send/receive messages through a serial data stream

- The DVSM Monitor application shall display all cameras attached to the system regardless of their physical location on the network.

- The DVSM Monitor application shall display all camera sequences created in the system.

- The DVSM Monitor application shall allow for unlimited cameras sequences, which can be run independently of each other on either digital monitor tiles or analog CCTV monitors.

- The DVSM Monitor application shall allow operators to control (Pause/Play, skip forwards, skip backwards) Camera Sequences, without affecting other operators' ability to view and control the same sequence.

- The DVSM Monitor application shall display all cameras, sequences and analog monitors in a logical tree.

- The DVSM Monitor application operator shall be able to drag and drop a camera from a tree of available cameras into any video tile or an analog monitor icon for live viewing.

- The DVSM Monitor application operator shall be able to drag and drop a camera sequence from a tree of cameras into any video tile or an analog monitor icon for live viewing.

- The DVSM Monitor application shall support Graphical Site Representation (Maps) functionality, where digital maps are used to represent the physical location of cameras and other devices throughout facility.

    i. The DVSM Maps shall have the ability to contain hyperlinks to create a hierarchy of interlinked maps.

    ii. The DVSM Maps shall be able to import maps from any graphical software supporting BMP, JPEG and/or GIF image formats.

- The DVSM Monitor application operator shall be able to drag and drop a camera from a map into a video tile for live viewing.

- The operator shall be able to click on an icon in a map to initiate PTZ camera preset, run PTZ pattern, view camera in an analog monitor or send an I/O stream.

- The DVSM Monitor application shall support the procedure functionality, where procedures can be triggered to appear during a certain event and can be used to provide detail written or verbal instructions to the operator as to the actions to be taken.
- The DVSM Monitor application shall support digital zoom on a fixed camera's live and recorded video streams.

- The DVSM Monitor application shall support digital zoom on a PTZ camera's live and recorded video streams

- The DVSM client shall provide the following video analytics alarm options:
    a) Trigger alarms or events to draw the user attention
    b) Provide a meaningful text description of the event.
    c) Provide OSD graphics to depict the analytics event, including the participating objects, event location, motion directions and more.
    d) Provide the above OSD graphics on live video, archived video and JPEG images
    e) Support automatic tagging/book-marking of analytics events
    f) Support search of analytics events history.

- The DVSM Monitor application shall provide management and control over the system using a standard PC mouse, keyboard and CCTV Joystick controller. The vendors should provide joystick controller as an integrated part of each client workstation.

- The DVSM client shall be able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including cameras of various manufacturers' brands, including their PTZ functionalities (i.e.: one keyboard manufacturer controls other manufacturer's dome or vice-versa).

- The DVSM client shall allow for a CCTV keyboard to be attachable directly to the PC running the DVSM client application via its serial port.

- The DVSM client CCTV Keyboard Interface shall provide full PTZ control.

- The operator shall be able to control pan-tilt-zoom, iris, focus, dome relays and dome patterns

- The DVSM client software shall allow the operator to access the PTZ configuration menus with no need of additional hardware.

- This shall prioritize which operator has control over camera vs another operator trying to control the same camera at the same time.

- The DVSM client CCTV Keyboard Interface shall provide full video matrix operations

ALARM MANAGEMENT

1 The IP based DVSM shall provide alarm management and reporting module
2 The IP based DVSM shall notify a user on any alarm set in the system
3 The DVSM user shall be able to support multiple alarms
4 The DVSM system administrator shall be able to set for each user the maximum alarms to be viewed at one time
5 The DVSM user shall be able to forward alarms to other users
6 The DVSM alarm management shall keep audit trail of all alarm and operators
related operations in a separated database.
7 The DVSM alarm database shall provide multi time schedule support and shall be able to save the alarm database for different period of time as the recorded video schedule.

INTEGRATION INTERFACE

1 DVSM should provide well defined SDK/API for integration development possibilities with third party systems. Development of integration module will be in the scope of BMS system OEM, whereas DVSM vendor should provide the requisite SDK/API for the same. Cost of the same should be

included in the offer.

2 All the cameras should also provide potential free alarm inputs and potential free relay output to achieve integrations with some non IP products.

Hardware Compliances to be filled in by Bidders:-

Sr	Description	Compliance YES / NO	Deviated Specs, with Explanation
A	**IP Fixed Dome Color Standard Resolution Camera**		
1	0.5 MP ,1/3" CCD Progressive/ CMOS		
2	Minimum Illumination 0.12lux		
3	Auto Iris 2.8-10 mm varifocal,		
4	Adjustable Horizontal coverage between 30° to 85°		
5	Manual pan/tilt adjustment up to 340°/180°		
6	Automatic Gain Control, BLC, White balance: On/Off		
7	Compression : Dual stream, H.264 & MPEG-4 user configurable per stream		
8	Resolution: Adjustable from 320x240 to 800X600 with capability of 800X600 @ 25FPS for both the streams simultaneously.		
9	Bandwidth : 64Kbps to 6Mbps		
10	Built-in Multi-zone motion detection		
11	External audio Input and output: Required with up to 16khz sampling rate		
12	Unicast, Multicast, RTP, TCP, UDP, HTTP, IGMP, ICMP, DHCP, DNS		
13	10/100 Base-T Auto sensing, Half/Full Duplex (RJ45)		
14	S/N Ratio: >50db		
15	2 potential free dry inputs, 1 Relay out		
16	Power : 802.3af class 3 PoE auto sensing		

17	Weather proof IP54, surface mount enclosure.		
18	Mount: Surface		
19	Operating Temp: -10° C to 50° C		
20	Humidity : 90% (Non-condensing)		
21	UL,CE and FCC certified		
B	**IP Fixed Dome Day/Night High Resolution Camera**		
1	1.0 MP,1/3" CCD Progressive/CMOS		
2	Minimum Illumination 0.12lux@f1.2		
3	2.8-10 mm varifocal, Auto Iris, IR corrected lens		
4	Adjustable Horizontal coverage between 30° to 85°		
5	Manual pan/tilt adjustment up to 340°/180°		
6	Automatic Gain Control, BLC, White balance: On/Off		
7	Compression : Dual stream, H.264 & MPEG-4 user configurable per stream		
8	Resolution : Adjustable from 352x288 to 1280X1024 with capability of 1280X1024 @ 25FPS for both the streams simultaneously.		
9	Bandwidth : 64Kbps to 6Mbps		
10	Built-in Multi-zone motion detection		
11	External audio Input and output: Required with up to 16khz sampling rate		
12	Unicast, Multicast, RTP, TCP, UDP, HTTP, IGMP, ICMP, DHCP, DNS		
13	10/100 Base-T Auto sensing, Half/Full Duplex (RJ45)		
14	S/N Ratio: >50db		
15	2 potential free dry inputs, 1 Relay out		

16	Power : 802.3af class3 PoE auto sensing		
17	Weather proof IP66, Vandal resistant Sunshield, Built in heater and blower, surface mount enclosure.		
18	Mount: Surface		
19	Operating Temp: -10° C to 50° C		
20	Humidity : 90% (Non-condensing)		
21	UL,CE and FCC certified		
C	**IP Fixed Box High Resolution Day/Night Camera Outdoor Camera.**		
1	1.0 MP,1/3" CCD Progressive/CMOS		
2	Minimum Illumination : 0.2 lux @30IRE		
3	2.8-10mm varifocal, Auto Iris , IR corrected lens		
4	Automatic Gain Control, BLC, White balance: On/Off		
5	Compression : Dual stream, H.264 & MPEG-4 user configurable per stream		
6	Resolution : Adjustable from 352x288 to 1280X1024 with capability of 1280X1024 @ 25FPS for both the streams simultaneously.		
7	Bandwidth : 64Kbps to 6Mbps		
8	Built-in Multi-zone motion detection		
9	External audio Input and output: Required with up to 16khz sampling rate		
10	Unicast, Multicast, RTP, TCP, UDP, HTTP, IGMP, ICMP, DHCP, DNS		
11	10/100 Base-T Auto sensing, Half/Full Duplex (RJ45)		
12	S/N Ratio: >50db		
13	2 potential free dry inputs, 1 Relay out		

14	Power : 802.3af class 3 PoE and 12VDC/24VAC auto sensing		
15	Vandal resistant cast aluminum enclosure with IP66, Sunshield, built in heater & blower with 15 mtr IR illuminator and wall mount.		
16	Operating Temp: 0° C to 50° C		
17	Humidity : 90% (Non-condensing)		
18	UL,CE and FCC certified		
D	**IP High Resolution PTZ Camera with 27X Optical Zoom, Day/Night, WDR**		
1	1/4" CCD Progressive 27 X (3.4 to 91.8 mm) Optical Zoom		
2	Minimum Illumination : 0.01 Lux @ 30 IRE		
3	Wide Dynamic Range		
4	Auto iris, Auto focus, Motorized 4.1mm-73.8mm or better zoom lens with 30 mtr IR illuminator.		
5	Automatic Gain Control, BLC, White balance: On/Off		
6	Compression : Dual stream, H.264 & MPEG-4 user configurable per stream		
7	Resolution: Adjustable from 352x288 to 720x576 with capability of 720x576 @ 25FPS for both the streams simultaneously.		
8	Bandwidth : 64Kbps to 6Mbps		
9	Built-in Multi-zone motion detection		
10	Unicast, Multicast, RTP, TCP, UDP, HTTP, IGMP, ICMP, DHCP, DNS		
11	10/100 Base-T Auto sensing, Half/Full Duplex (RJ45)		
12	S/N Ratio: >50db		
13	Endless 360° pan and -5° to +95° tilt movement		

14	Manual Pan/tilt speed up to 90 deg per second and preset speed up to 300 deg per second		
15	128 preset positions and 3 tour patterns		
16	External audio Input and output: Required with up to 16khz sampling rate		
17	2 potential free alarm inputs, 1 Relay out		
18	Power : 24VAC (Outdoor)		
19	Vandal resistant dome enclosure, IP66 rated, Built in heater and blower, wall mount. Enclosure should be of same make as that of camera		
20	Operating Temp: -10° C to 50° C (Outdoor)		
21	Mount: Wall or pole or pipe (Outdoor)		
22	Humidity : 90% (Non-condensing)		
23	UL, CE and FCC Certified		
E	**IP Fixed Box High Resolution Day/Night WDR Camera with advance Video Analytics Support**		
1	1.0 MP, 1/3”CCD Progressive/CMOS		
2	Minimum Illumination : 0.2 lux @30IRE		
3	2.8-10mm varifocal, Auto Iris , IR corrected lens		
4	Wide Dynamic Range		
5	Automatic Gain Control, BLC, White balance: On/Off		
6	Resolution : Adjustable from 352x288 to 1280X1024 with capability of 1280X1024@ 25FPS		
7	Dual streaming		
8	Bandwidth : 64Kbps to 6Mbps		
9	Video analytics support: User configurable Trip Wire, Object left behind, Loitering, Illegal parking etc.		
10	Unicast, Multicast, RTP, TCP, UDP, HTTP,		

	DHCP, DNS		
11	10/100 Base-T Auto sensing, Half/Full Duplex (RJ45)		
12	S/N Ratio: >50db		
13	1 potential free dry inputs, 1 Relay out		
14	Power : 802.3af class 3 PoE and 12VDC/24VAC		
15	Vandal resistant cast aluminum enclosure with IP66, Sunshield, built in heater & blower with 15 mtr IR illuminator and wall mount.		
16	Operating Temp: 0° C to 50° C		
17	Humidity : 90% (Non-condensing)		
18	UL, CE and FCC Certified		
	Note: Vendors can offer Server based or Edge based analytics as per recommendation of offered system OEM. In case of server based analytics dedicated industrial grade servers should be provided for analytics, same as that of recording servers except storage size.		
G	**Analogue Fixed dome camera for Lift cars**		
1	1/3" CCD Sensor		
2	520TVL resolution		
3	Minimum Illumination : Color 0.6lux and B/W 0.4lux		
4	Auto Iris. 8-10mm varifocal,		
5	Adjustable Horizontal coverage between 30° to 85°		
6	Manual pan/tilt adjustment up to 340°/180°		
7	Automatic Gain Control, BLC, White balance: On/Off		

8	Power : 12VDC/24VAC auto sensing		
9	Weather proof IP66, Vandal resistant clear bubble surface mount enclosure.		
10	Mount: Surface		
11	Operating Temp: -10° C to 50° C		
12	Humidity : 90% (Non-condensing)		
13	UL,CE and FCC certified		
14	To be supplied with Coax-UTP converter pair		
H	**Single Channel High Resolution Video**		
1	Compression : Dual stream, H.264 & MPEG-4 user configurable per stream		
2	Resolution : Adjustable from 352x288 to 720x576 with capability of 720x576 @ 25FPS for both the streams simultaneously.		
3	Bandwidth : 64Kbps to 6Mbps		
4	Built-in Multi-zone motion detection		
5	External audio Input and output: Required with up to 16khz sampling rate		
6	Unicast, Multicast, RTP, TCP, UDP, HTTP, IGMP, ICMP, DHCP, DNS		
7	10/100 Base-T Auto sensing, Half/Full Duplex (RJ45)		
8	2 potential free dry inputs, 1 Relay out		
9	Power : 802.3af class 3 PoE and 12VDC/24VAC auto sensing		
10	Aluminum enclosure		
11	Operating Temp: 0° C to 50° C		
12	Humidity : 90% (Non-condensing)		
13	CE and FCC certified		
I	**High Configuration Server with Expandable External Direst Attached Storage**		

	19" As per list of makes rack mounting.		
	two Quad Core Processor of 2.0 Ghz, 12M Cache, 1333 MHz		
	Microsoft® Windows 2003 Server R2 Standard Edition, SQL database/ Linux Embedded		
	12 TB (Dual mirrored) 15K RPM Serial-Attach SCSI 6Gbps Hot plug Hard Drive for OS and External RAID6 configured storage array for video storage.		
	Dual Network Interface Card - 100/1000 MB		
	Dual/Redundant power supply		
	Standard video display adapter		
	CD-ROM		
	3 Year Next Business Day On Site Hardware Warranty from OEM		
J	**Direct Attached Storage**		
	Up to fifteen (24) SATA II hot-pluggable 6.0 Gbps hard drives, at speeds of 7,200 RPM		
	Loaded with **24TB usable (12TB x 2** RAID6 configured with minimum one as hot spare drive).		
	Upgradeable for dual host support providing direct connectivity for two partitions		
	LED indications for System status, Power, Split mode, Activity, Drive indicator per drive, fan fault, SAS ports etc.		
	Configured with RAID6. Support for RAID levels 0, 1, 5, 6, 10, 50		
	Operating temperature up to 35 degree Celsius		
	3 Year Next Business Day On Site Hardware Warranty from OEM		

	Note: Minimum 2 servers with above specifications i.e. max 75 cameras per server is considered. **Vendors who may need additional servers to meet failover database, failover recording requirements should include the same as required.**		
10	**High Configuration Client Workstation**		
	Workstation shall be of Dell, HP or IBM make		
	Intel Xeon X5650,2.66GHz,12M,6.4GT/s, 3x1GB or more of RAM		
	Microsoft® Windows XP PRO SP3 with Windows Vista Business License		
	160GB SATA,10K RPM 3.0Gb/s Hard Drive for OS and VMS Applications		
	Network Interface Card - 10/100/1000 MB		
	Video Card – nVidia 2 x NVS295 Quad Monitor Graphics card to support 4 multiplexed Monitors		
	DVD-R/W		
	3 Year Next Business Day On Site Hardware Warranty from OEM		
11	**Medium Configuration Client Workstation**		
	Workstation shall be of Dell, HP or IBM make		
	Intel Xeon E5630,2.53GHz,12M,5.86GT/s 3x1GB or more of RAM		
	Microsoft® WINDOWS XP PRO SP3 with Windows Vista Business License		
	160GB SATA,10K RPM 3.0Gb/s Hard Drive for OS and VMS Applications		
	Network Interface Card - 10/100/1000 MB		

	Video Card – nVidia, NVS 295, 256MB dual DVIGraphics Card to support 2 multiplexed Monitors		
	DVD-R/W		
	3 Year Next Business Day On Site Hardware Warranty from OEM		
12	**General Guidelines for Network Switches**		
	All network equipment shall be HP, Nortel, Cisco, Allied Telesis		
	All networking equipment shall be as minimum of Layer-2 and as a minimum shall support IGMP Snooping Version 2 or later and IGMP querier. It should have minimum two 1000baseT copper ports and minimum two slots for 1000baseT fiber modules.		
	The IP network shall support Multicasting between all ports and shall allow for Multicast streams to be routed between networks.		
	Switches should allow the configuration of VLAN accommodating the IP addresses from different subnets (Class B VLAN)		
	All the edge switches should be minimum Layer-2. All Layer-2 switches must finally be brought together using 1000baseT ports to central Layer-3 switch. Connection to the servers and clients must be 1000baseT from 10/100/1000baseT ports. Connection between Layer-2 and Layer-3 switch should preferably use fiber backbone. Each switch should have at least 30% spare ports of each type.		
	Layer 3 switch in main control room should be a modular switch so as more ports can be populated as required during the execution of the		

	project.		
	Uplink port should have sufficient speed to avoid network congestion, preferably network should not be loaded more than 70% at any stage.		

6.0 VENDOR SUBMITTALS AND DOCUMENTATION:

6.1 Documents to be included along with the offer (Original only).

- Descriptive catalogues for the equipment & selections data
- Rating charts and Dimensional Drawings of Equipment offered.
- Foundation drawings of the equipment, labeled with weights at each support point
- Maintenance proposal
- Spare Parts List
- Schematics
- Organization chart
- Bar chart

6.2.1 During the course of installation, contractor shall submit the following for Engineer's review prior to proceeding with work:

- Work program(s) as directed by the Project Manager
- A schedule of material/equipment submissions indicating the type of material/equipment, brand, sample provision, standards conformed, proposed date of submission/approval, order and delivery dates.
- 4 sets of detail submissions for materials/equipment that include catalogues, fabrication, fixing and installation details; technical data shall include performance, rated capacity, operating conditions, dimensions, maintenance access, etc.
- Material/equipment samples as required by the Engineer, which may include, but is not limited to, labeling system, painting system, color codes, support and fixing, etc.
- A schedule of all proposed shop drawings, showing expected submission and approval dates.
- Shop Drawings.
- System design information such as design calculations, flow charts, schematics, etc.
- Site testing and commissioning programs, and testing procedures.
- Testing results verified.
- Operation manuals

- As-built drawings

6.3 SHOP DRAWINGS

6.3.1 Prior to the commencement of works, the Contractor shall submit Shop Drawings of equipment and assemblies produced by equipment vendors, indicating principle dimensions, fixings, mounts, connections and all other relevant details.

6.3.2 The Contractor shall prepare installation shop drawings to indicate clearly the proposed size, mounting level and route of cables, ductwork, pipes, etc. to be installed in this Contract, with sections and schematics. These shall demonstrate full compliance with specification and show all information necessary for the proper coordination and combined installation with other adjacent or affected contractors. Particular care shall be taken to demonstrate that the installation can be maintained in accordance with the manufacturer's recommendations, and that due consideration is given for parts replacement.

6.3.3 Four (4) sets of A0 /A1 size shop drawings and electronic copy (AutoCAD files) shall be submitted and approved prior to the commencement of work.

6.3.4 The timing of drawing submission by the Contractor shall make allowance for Engineer's review, Contractor's adjustment, and resubmission(s) to achieve approval before commencement of work. In general the Engineer will require two weeks to carry out each review. The Engineer may require the Contractor to remove any installation done (or equipment/materials delivered) prior to drawing approval at the Contractor's own cost.

6.4 AS-BUILT DRAWINGS & OPERATING MANUALS

6.4.1 The Contractor shall submit As-Built drawings that have been reviewed and deemed satisfactory by the Engineer. Final submission shall include four (4) sets of A1 size, one set of A3 size and two sets of electronic copy (AutoCAD files) on CD-ROM disc.

6.4.2 The Contractor shall submit three (3) copies of an operating manual that have been reviewed and deemed satisfactory by the Engineer

The manual should include:

- General description of equipment and system.
- Operating instruction for all equipment and system.
- Schedule of equipment clearly stating the type, make, model, serial number, quantity, capacity, location and date of installation.
- Manufacturer's literature including catalogues, wiring diagrams, technical description, etc.
- Recommended frequency and detailed task list for routine maintenance for each

system and equipment

- Final factory and site testing results for each equipment and each system with signatures of witnesses.
- Emergency contact lists for 24-hour, 365-days including duty and backup personnel.

6.5 CLOSE-OUT DOCUMENTS

1. Submit final copies of the shop drawings outlined as above. These final submittals shall reflect all field modifications and change orders required to complete the installation. Submit the following quantities of record submittal drawings immediately following receipt of notification of substantial completion. Auto CAD drawing or VISIO files of all shop drawings on or CD ROM disks.
2. Three complete sets of documents located in a Spiral Bound notebook and organized by subject with divider tabs.

6.6 CLOSEOUT MINIMUM REQUIREMENTS

The IBMS Contractor shall ensure the following are completed at hand-over:

6.6.1 Any snagging to be documented and agreed date determined for clearance.

6.6.2 All passwords/PIN numbers, levels and operators recorded.

6.6.3 Disk copies of all system and data files supplied.

6.6.4 Proprietary software manuals & disks.

6.6.5 Consumables, printer ribbons, printer paper at agreed levels.

6.6.6. All equipment access keys handed over.

6.6.7 Complete sets of O&M manuals left with system, any agreed amendments/additions required to be documented and a target date for completion agreed.

6.6.8 Training of engineers and operators to be checked complete or program for completion agreed.

7.0 QUALITY ASSURANCE

7.1 GENERAL

7.1.1 The IP CCTV Surveillance System shall be furnished, engineered, and installed by Trained Engineers of the Contractor.

7.1.2 The contractor shall have extensive knowledge in the System Network Integration or shall be a factory trained and certified Integrator.

7.1.3 The contractor shall employ technicians who have completed the factory authorized training. The contractor shall employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

7.2 SYSTEM INTEGRATOR QUALIFICATIONS

7.2.1 The system integrator must be an authorized representative in good standing of the manufacturer of the proposed hardware and software components.

7.2.2 The system integrator shall have an office that is staffed with designers trained in integrating interoperable systems and technicians fully capable of providing instruction and routine emergency maintenance service on all system components.

7.2.3 The system integrator shall have in house capabilities to implement Security strategies for whole building control.

7.2.4 The system integrator shall have a service facility, staffed with qualified service personnel, capable of providing instructions and routine emergency maintenance service for networked Security Control systems.

7.3 HARDWARE AND SOFTWARE COMPONENT MANUFACTURER QUALIFICATIONS

7.3.1 The manufacturer of the hardware and software components must be primarily engaged in the manufacture of IP CCTV Hardware and Software Solutions based systems as specified herein, and must have been so for a minimum of Five (5) years.

7.3.2 The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing

instruction and technical support service for networked control systems.

7.3.3 The manufacturer & Bidder (if separate Entities) of the hardware and software components must have experience of no less than Six (6) similar projects, with the Bidder executing at least 1 Project of Minimum 600 IP Cameras on a Single Installation, and a Integrated IP CCTV Management Software, which have extensive hardwired and Software level integration with various other building Utilities & building systems.

7.3.4 These projects must be on-line and functional such that the Client / Owners/Users representative should be able to visit such as installation and observe the system in full operation, when demanded by the Client.

7.4 QUALITY ASSURANCE DURING EXECUTION

7.4.1 Physical Examination :-

A. Verify that systems are ready to receive work.

B. Beginning of installation means installer accepts existing conditions.

C. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

D. The contractor shall inspect the site to verify that equipment is installable as show, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

E. The IP CCTV System Contractor shall examine the drawings and specifications for other parts of the work, and if head room or space conditions appear inadequate or if any discrepancies occur between the plans and his work and the plans for the work of others, he shall report such discrepancies to the Architect/Engineer and shall obtain written instructions for any changes necessary to accommodate his work with the work of others.

7.5 FIELD QUALITY CONTROL

7.5.1 All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and National codes and ordinances as identified earlier of this Section.

7.5.2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and/or wiring runs shall be installed parallel to building lines and properly supported.

7.5.3 Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

7.6 IDENTIFICATION OF HARDWARE AND WIRING

7.6.1 All wiring and cabling, including that within factory-fabricated panels & field Equipments shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

7.6.2 Permanently label or code each point of field terminal strips to show the instrument or item served.

7.6.3 Identify control panels and Field Equipment with minimum 1 inch letters on nameplates.Identify all other control components with permanent aluminium anodised labels. (Not Stickers)

7.6.4 Identifiers shall match record documents.

7.6.5 Identify auxiliary componments relating to camera, switches or other important field Equipment with nameplates.

8.0 GENERAL DESIGN FEATURES / PERFORMANCE CRITERIA

Refer Chapter 4 “Product Specifications”

9.0 DELIVERY, STORAGE AND HANDLING:-

9.1 CONTRACTOR'S RESPONBILITY

- It shall be the responsibility of the Contractor to ensure delivery of the equipment to the site free of any damages to the latter.
- Any Loading / Unloading Charges or incidental expenses thereof shall be borne by the Contractor for safe transit and storage of the equipment, and no further claim shall be made to the client on this account.
- It shall be the responsibility of the Contractor to inward all material with proper emphasis on documentation and clearance from the Consultant / Client and project managers.
- Any Damaged Equipment supplied to the site shall be immediately replaced under notice to the client's project Supervisor / Manager at site.
- The Contractor shall provide for a safe and secure storage of the Equipment supplied under Lock and Key and shall indemnify the client against any on-site damage or theft of the Equipment, for which the contractor has realized the monies from the Client.

9.2 PROTECTION

9.2.1 The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.
9.2.2 The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted.
9.2.3 The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site that is not immediately installed.
9.2.4 The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

9.3 CLEANING

9.3.1 This contractor shall clean up all debris resulting from his or her activities daily.
9.3.2 The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed.
9.3.3 Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.
9.3.4 At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dirt and debris, etc.
9.3.5 At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas.

9.3.6 Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

10.0 GENERAL INSTALLATION PROCEDURES AND REQUIREMENTS.

10.1 Install all control components in accordance with manufacturer's instructions and recommendations.

10.2 Mount Cameras / Transponders / Switches / Routers / Field located equipment adjacent to associated equipment on vibration-free walls or freestanding angle iron supports.

10.3 Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face.

10.5 After completion of installation, test and adjust control equipment. Submit data showing setpoints and final adjustments of controls.

10.6 Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

10.7 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

10.8 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

10.9 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

10.10 ELECTRICAL SYSTEM INSTALLATION

10.10.1 Comply with all NEC and NBC Installation Requirements.

10.10.2 Install low voltage power and LAN communication trunks in conduit / or as Armoured in the following locations regardless of local building code allowances otherwise.

1. Mechanical rooms.
2. Electrical rooms.
3. Vertical risers (exception: fire rated continuous closet like a telephone closet).
4. Open Areas where the wiring will be exposed to view or tampering.

10.10.3 Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

10.10.4 Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

10.10.5 Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

10.10.6 Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 3m (10 ft.) intervals.

10.10.7 All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

10.10.8 Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

10.10.9 Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

10.10.10 Set conduits as follows:

1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
2. Oakum and lead, sealed watertight penetration through outside foundation walls.

10.10.11 Cap open ends of conduits until conductors are installed.

10.10.12 Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

10.10.13 Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

10.10.14 Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

10.11 SEQUENCE OF OPERATIONS

A. Refer to drawings for normal operating mode sequences of operations.

B. General.

1. Provide automatic control for system operation as described herein, although word "automatic" or "automatically", is not explicitly used.
2. Provide control devices, Management software and control wiring as required for automatic operation of each sequence specified, and in line with the DVMS Specifications earlier in the Tender.
3. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.
4. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.
5. Functions called for in sequence of operations are minimum requirements and not to limit additional capabilities the CCTV system can be provided with.

11.0 TESTING AND COMMISSIONING, TRAINING

11.1 COMMISSIONING

11.1.1 The CCTV specialist shall be responsible for the full commissioning of his system and any other Networking and allied equipment supplied by him.

11.1.2 All safety interlocks, overrides and fail-safe conditions are to be operational prior to starting the plant. Demonstrate as agreed with the engineer prior to starting the CCTV Surveillance Systems

11.1.3 Fault conditions for all critical alarms, safety devices and control interlocks shall be simulated and proved effective as soon as practical, prior to Final Testing and Commissioning of the CCTV System.

11.1.4 All filed devices including CCTV Cameras, Switches and Networking Equipment shall be checked to ascertain accuracy within limits,

11.1.5 All the necessary test equipment and materials used in commissioning shall be supplied by the IP CCTV Contractor. All test equipment shall have valid test certificates & Calibration Certificates.

11.1.6 Simulated inputs shall be employed to check stability over the design environmental range.

11.1.7 The IP CCTV System contractor shall allow additional workdays, by his commission ing engineer to revisit the system at a later date (after hand-over) for Recheck and re-establishment of all demonstrated parameters, if required– to the discretion of the Client / Consultant.

11.1.8 The Contractor shall check and adjust operational parameters, and re-tune any control as maybe required by change in the monitoring / Recording/ Retrieval System parameters for the IP CCTV Management System

11.1.9 Commissioning documentation and schedules shall be submitted for approval during the design phase showing each camera, utility of the camera, view characteristics, implied importance matrix, recording / failover redundancy parameters to be programmed in line with the directions of the Consultant; and the stages of checks and commissioning required.

11.1.10 Each cleared item to have date and engineer reference. Completed copies shall be available to the Security Consulting engineer prior to acceptance testing.

11.1.11 A complete set of the commissioning documentation is to form part of the system documentation.

11.1.12 Once any item of plant is commissioned, documentation showing the overrides, control and software configuration shall be available on site at all times.

11.1.13 All system documentation shall be in accordance with standard templates.

11.2 TESTING OF IP CCTV SYSTEMS

General Internal Testing Matrix for the Contractor as a minimum requirement before calling the Consulting Engineer for Further testing shall be :

Sr No	Description	Visual	Test Readings	Documentation
1	All cables are tested for continuity, insulation, resistance		√	√
2	System installation proper as per drawing	√		
3	Carry out visual checks on all cameras, cables, camera housing etc., to ensure they are clean and free from any mechanical damage	√		
4	Check for proper termination & ferulling	√		
5	Check input supply for camera Power Supply units		√	
6	Check Input supply DC voltage at every camera .		√	
7	Check all camera's signal on monitor. Also check for clarity , sharpness of the picture.	√		
8	Check PTZ controls of PTZ camera	√		
9	Check recording / plaback FRAME RATE	√	√	
10	Check server software & client software is installed without any bugs	√		√
11	Set programming of all cameras through software.	√		√
12	Check remote viewing of cameras on internet/WAN	√		

11.2.1 Upon completion of the installation, Contractor shall start-up the system and perform all necessary calibration and testing to ensure proper operation of the IP CCTV systems.

11.2.2 Schedule a hardware & Software demonstration and system acceptance test in the presence of the Contracting Officer and the Security Consulting Engineer.

11.2.3 The acceptance testing is defined as demonstrating the set parameters in the acceptance test documents, and as indicated in the drawings; to achieve the Security Consulting Engineer's predefined expected functionality for the CCTV Systems, in line with the tender requirements.

11.2.4 The Contractor shall perform all tests prior to scheduling the acceptance test and hardware demonstration to insure the overall system is ready for inspection and observations.

11.2.5 When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and be deemed substantially complete.

11.3 Acceptance Demonstrations

11.3.1 The IP CCTV Contractor shall give seven days notice to the Consulting engineer of his intention to provide the acceptance demonstrations once the commissioning is complete.

11.3.2 The operation of all safety interlocks, and all third party Integrations shall be tested by the Security Consulting Engineer and demonstrated for operation/accuracy.

11.3.3 Should more than 1% fail performance test, a further ten per cent may be selected.

11.3.4 If above 5% fail the Consultant may at his discretion demand 100% demonstration.

11.3.5 The IP CCTV Contractor shall supply sufficient man-power/test equipment, consumable items and portable telephones to conduct the demonstration efficiently.

11.3.6 Testing shall also incorporate an audit of the wiring and hardware installation, demonstration of safety interlocks, start of system from power-down and review of time schedules and alarm levels, grouping and selected control parameters.

11.4 TRAINING OF OPERATING PERSONNEL:

11.4.1 All training shall be by the IP CCTV Systems Contractor and shall utilize specified manuals, as-built documentation, and the on-line help utility.

11.4.2 Operator training shall include four initial eight-hour sessions, or more , to the discretion of the Client / Consulting Engineer.

11.4.3 The initial operator training program shall be to establish a basic understanding of the IP CCTV software, the Control Matrix functions, commands; and the Casue Effect Diagram ETC.

11.4.4 Special Emphasis shall be laid by the Trainer on imparting knowledge to the participants on extracting the maximum mileage out of the Head-end application to achieve the intended goal of comprehensive safety and security to the entire premises.

11.4.5 The training shall encompass as a minimum:

1. Troubleshooting of field devices.
2. Sequence of operation review.
3. Sign on - sign off.
4. Selection of all displays and reports.
5. Use of all dialogue boxes and menus.
6. System initialization.
7. GUI Software.
8. Network Management Software.
9. Toggling between various screens.
10. Understanding of Alaytics and various Alarms
11. Setting of Analytics and reconfiguration with lower level programming.

12.0 INTERFACING WITH OTHER SERVICES.

12.1 Interfacing with Third Party Service providers and Equipment Providers is a integral and most important part of the scope of works of the IP CCTV System vendor. Further, Interfacing with other Security System Providers such as Access Control, Gating Solutions, Vehicle Barrier Systems.

12.2 It shall be the Contractor's responsibility to study and inclulate the Design Logics of various Related Utilities being provided by third parties, especially Security Applicances.

12.3 It is expected and assumed for granted that the Contractor shall study of third party drawings to locate equipment / locate Marshalling boxes, as required to pick up signals relevant to Security Monitoring and Control of the sensitive areas.

12.4 The Contractor shall also ask and obtain data related to software level integrations on .net / xml / or other open integration platforms, to enable a integrated Security Envionment in the Premises.

12.4 The Contractor shall be responsible to ensure that all information relevant to Interfacing with Other Services and Other Systems is collated an put to use to ensure a fully operational Security System with full control and monitoring of the preidentified surveillance areas in building.

12.5 During Execution, it shall be Contractor's responsibility to follow Co-ordinated drawings and interface with other Services and contractors for proper laying and installtion of equipment such that there is no fouling of services in any manner.

13.0 MODE OF MEASUREMENTS

13.1 At various Logical Stages of the project, the Contractor shall ensure that joint measurements are taken, recorded and filed after the approval from the project managers / Consultants.

13.2 The contractor shall provide their own blank measurement sheets for the approval of the project managers /consultants to ensure conformance to minimum information requirement on the subject document.

13.3 All Cabling Nodes for IP CCTV – i.e., from the Cameras to the Switches, Panel shall be measured for Copper type CAT 6 or equivalent Ethernet cabling, per meter basis.

13.4 Fiber Optic cable from Layer 2 Field mounted Switches to Layer 3 Switches at the Control Room shall be measured separately at per meter basis.

13.5 Power Cable from Field Power Supplies to the PTZ Cameras or other such Equipment shall be measured separately per meter basis.

13.5 Location of the Camera's, switches and other field equipment, type of cameras, Enabling of analytics on specific cameras as per security needs shall be cross checked by the Consulting Engineer, the Contractor and the project manager as installed on site.

13.6 Equipment actually installed at site, against the individual line items shall be checked for conformance, and joint measurement taken for Quantities, and then Certified.

14.0 OPERATION AND MAINTENANCE

14.1 The Contractor shall offer prices against the Operations and Maintenance contracts as asked for in the Tender.

14.2 Operations would mean manning the CCTV System stations 24 x 7. This would entail the contractor providing for atleast 5 nos. or more of trained technical manpower of Diploma Engineer level on their payroll, present on the site at any given time. This team shall be responsible for smooth operation of the IP CCTV System, Reports generation, trend viewing, analysis and reports to the Facility Management team / Client.

14.3 It shall be the Contractors responsibility to provide their appointed Operations team to provide all tools, instrumentation and other accessories to enable them to fulfill the desired function.

14.4 The Client shall enter in to a Service level Agreement with the Contractor for the purpose of the Operations contract. Such an Agreement will list the response time to a client requirement and related parameters. The Agreement may also list of events / alarms to the escalation matrix based on the response required for the event.

14.5 The Contractor shall provide the Replacement warranty for the components installed, while under the defects liability period.

14.6 Under the DLP, the Contractors shall undertake all necessary maintenance and repair / replacement activities to ensure 99.9% uptime of all the installed Equipment and the IP CCTV system as a whole.

14.7 On the Completion of the DLP, the client may chose to enter in to a Comprehensive or non Comprehensive maintenance contract with the IP CCTV Systems Contractor for the purpose of regular planned and Emergency Maintenance of the system.

14.8 A Separate Maintenance Agreement and linked service parameters shall be defined in the SLA.

14.9 As a Minimum, whether under DLP or under Maintenance Contract post DLP, the expected resolution time shall be as follows:

- for minor complaints / maintenance issues : Max 4 Hours
- for Major Maintenance issues: Max 24 hours
- for Replacement of Level1 Importance components: Max 12 hours
- for Replacement of Level 2 Importance components: Max 48 hours.

15.0 SPARE PARTS PROPOSAL

15.1 It is expected that the Contractor advises the client the minimum spares that need to be stocked on site.

15.2 Further, the Contractor needs to Stock key components that may affect the working of the IP CCTV system at his own premises without any additional cost implication to the client, and ensure the minimum resolution times as defined in 14.9; or as defined and agreed in the SLA are met with.

a) List of Parts recommended to be kept on site (the total price of this section shall be in line with the tender BOQ Requirement).

b) List of Parts expected to have planned replacement within the first 5 years of operation.

c) List of Parts that are normally kept in the Contractor's Delhi warehouse, for delivery to site within 12 hours.

d) List of Parts that would be required to be ordered/imported (including expected delivery times).

Annexure-1

LIST OF APPROVED MAKES FOR LV SYSTEMS

Contractor shall use the material of approved make as indicated below unless specified otherwise in BOQ or as approved by the Employer's representative.

The Contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, Employer's representative/engineer reserves the right to opt for best preferred listed make.

The Contractor shall quote the rate for material and equipment as per the list of approved makes. In the event of the Contractor wants to use alternate makes other than those stipulated for any reason, the Contractor can send a proposal after ensuring that what he proposes at the least meets both the quality, and safety standard of the stipulated makes, and the financial benefit that will accrue to the Employer. He shall also stand fully guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the employer, whose decision will be final in the matter.

Sl No	**Item Description**	**Approved Makes**
1.0	**Building Management Systems**	HONEY WELL Limited JOHNSON CONTROLS (I) Private Limited NOVAR Private Limited SIEMENS Private Limited SCHNEIDER Private Limited (TAC) Trane
1.1	Supervisory Controllers/ DDC Controllers	Johnson/ Siemens/ Honeywell/ Trane/ Schnieder (t.a.c.)
1.2	Temperature, Air humidity Sensors (Duct, Room)	Siemens/Johnson/ Honeywell/ Trane/ Schnieder (t.a.c.)
1.3	Modem	Siemens/Johnson/ Honeywell/Trane/ Schnieder(t.a.c.)
1.4	Differential pressure switch Air flow / Water Flow switch/water Level switch	Siemens/Johnson/Trane/ Honeywell/Schnieder(t.a.c.), Indfoss, Switzer
1.5	Water Flow meter	Siemens/Invensys/Kele/ Honeywell/ Sontay
1.6	Water Pressure Transmitter	Johnson/Siemens/ Honeywell/Trane/Schnieder (t.a.c.)
1.7	Motorized Butterfly valves/ actuators	Johnson/Siemens/Belimo/ Honeywell
1.8	Motorized 2-way valves with actuator	Johnson/Siemens/Honeywell/Schnieder(t.a.c.)
1.9	Voltage/KWH Transducers with digital display/Electronic Meter	Situ Electro Instuments Pvt.Ltd./ Secure metres Ltd./ Enercon/L&T
1.10	Communication Cables	Commscope/Contemp/AT&T/Fusion Polymers/Finolex/Skyline/Belden

		Delton/Skytone
1.11	Signal Cables	Commscope/Contemp/AT&T/Fusion Polymers/ Delton/Skytone
1.12	Power Cables/FRLS Cables	Nicco, RPG, Universal, Gloster, Polycab
1.13	Main PC with CPU, Monitor, Keyboar	HP/Compaq/IBM
1.14	Printer	HP/Epson
1.15	Switching Relays	PLA/OMRON
1.16	Portable Handheld Programming device	Johnson/Trane/Siemens Honeywell/Schnieder(T.A.C.)
1.17	Flame proof level switch	Veksler/Minilec
1.18	Single Phase A.C. Contactor	MDS/L&T/Siemens/ Schnieder
1.19	4 Pole Three Phase A.C. Contactor	L&T/Siemens/ Schnieder
1.20	Controller Cabinet	Rittal/Eclotek
1.21	Auto manual switches (3 way)	Kaycee/L&T/ Schnieder
1.22	Auto manual changeover switch	Kaycee/ L & T
1.23	Current Relays	Sitn/Minilec/Sentry
1.24	G.I. Conduits	Steelkraft,BEC,AKG
1.25	Modem	Johnson/Siemens/Honeywell/Trane/ Schneider(T.A.C)
1.26	Steel Modular Furniture	Rittal/ Godrej or equivalent
2	**Public Address/Car Calling System**	Philips (Bosch), Haritasa, AHUJA through reputed vendors
2.1	Speakers	Philips (Bosch), Ahuja
2.2	Microphone	Philips (Bosch), Ahuja
2.3	Main Amplifier Rack	Philips (Bosch), Ahuja
2.4	Control Desk	Philips (Bosch), Ahuja
3	**Access Control System**	HONEYWELL LIMITED JOHNSON CONTROLS (I) Private Limited NOVAR Private Limited DATS Private Limited Siemens Schneider (T.A.C)
3.1	Proximity Card Readers	Cardax Series 125, Casirusco 9XX Proximity Perfect Cardkey Prox 1000 HID
3.2	Proximity Cards (ISO Thickness)	Cardax HID ISO Prox Casirusco Card Key
3.3	Door Controllers capable for multiple card readers, magnetic contacts, magnetic locks etc	Cardax FT-3000 Casirusco RP 8 Micro/5 Cardkey CK - 721 DDS

		Schneider
3.4	Electromagnetic Lock	Trimec EML600 Monitored Prolock (Canada)PL 600 BEL (Samples to be approved)
3.5	Magnetic Contact	Sentrol 1085 Senator (Samples to be approved)
3.6	Access Management Software	Cardax Casirusco Cardkey DDS Schneider
3.7	Boom Barriers	Frontier Pitts Delta Bavak
3.8	Flap Barriers	Magnetics/ Shivananda or Equivalent
3.9	GI conduit ISI embossed	BEC, AKG, Steel Craft
3.10	GI Conduit accessories superior type as per Approved Samples	Sharma Sales Corp./Super Sales Corp./Confirming to ISI as per Approved Samples.
4.0	**CCTV System**	**Approved Vendors** BOSCH HONEY WELL LIMITED JOHNSON CONTROLS (I) Private Limited SIEMENS Private Limited HONEYWELL/NOVAR Private Limited DATS Private Limited Schneider(T.A.C)
4.1	Digital Video Management softwares	Honeywell Pelco Everfocus BOSCH
4.2	CCTV Camera	Honeywell Pelco BOSCH
4.3	Servers/ Monitors	Honeywell Pelco BOSCH IBM DELL HP
4.4	GI conduit ISI embossed	BEC, AKG, Steel Craft
4.5	GI Conduit accessories superior type as per Approved Samples	Sharma Sales Corp./Super Sales Corp./Confirming to ISI as per Approved

		Samples.
5.0	**Electronic Billing**	Industrial Controls & Drives India Private Limited (with ICD meters) Enercon Systems Private Limited L&T C&A Division Ducati(Imported) Siemens Schneider (T.A.C)
6.0	***Analogue Addessable Fire Detection System***	
6.1	ADDRESSABLE MANUAL CALL POINT	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS/ EDWARD **Any other Vendor who meets the Technical Specifications and requirements**
6.2	ADDRESSABLE LOOP POWERED SOUNDER (ELECTRONIC HOOTER)	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS/ EDWARD **Any other Vendor who meets the Technical Specifications and requirements**
6.3	ANALOGUE ADDRESSABLE TYPE FIRE ALARM CONTROL PANEL	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS/ Schneider/ EDWARD **Any other Vendor who meets the Technical Specifications and requirements**
6.4	REPEATER PANEL	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS/ Schneider / EDWARD **Any other Vendor who meets the Technical Specifications and requirements**
6.5	ADDRESSABLE RELAY CONTROL MODULES / MONITOR MODULES / INPUT MODULES	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS/ EDWARD **Any other Vendor who meets the Technical Specifications and requirements**
6.6	SHORT CIRCUIT ISOLATOR	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS / EDWARD **Any other Vendor who meets the**

		Technical Specifications and requirements
6.7	RESPONSE INDICATOR	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS Agni/ Daksh / EDWARD **Any other Vendor who meets the Technical Specifications and requirements**
6.8	FIRE SURVIVAL CABLE (MICC CABLE) OF CWZ TYPE	PYROTENAX (TYCO)
6.9	ANALOGUE ADDRESSABLE TYPE SMOKE / HEAT / MULTI CRITERIA PHOTOELECTRIC/DUCT DETECTOR	HONEYWELL / NOTIFIER/ HOCHIKI / SYSTEM SENSOR / MORLEY / GENT / THORN / BOSCH / SIEMENS/ EDWARD **Any other Vendor who meets the Technical Specifications and requirements**

Annexure-2

DATA POINT SUMMARY FOR BUILDING MANAGEMENT SYSTEM														
	Project : Institute for Liver & Biliary Sciences at Delhi									Revision :				4
										Document. Date :				15.11.2011
Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
LOWER BASEMENT	A													
		WATER COOLED CHILLER PLANT ROOM	3 (2W +1S)											
	1			Chilled Water Supply Header Temp							√	√	√	
	2			Chilled Water Return Header Temp							√	√	√	
	3			Chilled Water Supply Header Pressure							√	√	√	
	4			Chilled Water Return Header Pressure							√	√	√	
	5			Chiller CHW Supply & Return Temp							√	√	√	
	6			Chilled Water Supply Temp Set point Reset						√			√	
	7			Chiller Start / Stop Command										
	8			CHW Flow Through Chiller Status (ON / OFF status)								√	√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS Integration.
	9			Chiller Enable						√			√	
	10			Chiller Auto / Manual Status					√			√	√	
	11			Chilled Supply Water Isolation Valve Open / Close Status								√	√	
	12			Chilled Supply Water Isolation Valve Open / Close CMD							√		√	
	13			Condensor Retun Water Isolation Valve Open / Close Status								√	√	
	14			Condensor Retun Water Isolation Valve Open / Close CMD							√		√	
	13			Emergency Shut down								√	√	
				General Fault Alarm								√		
	14			Soft Integration with Chiller on MODBUS / Bacnet / Lonworks Open Protocol										
	15			Soft Integration with BTU Meter at Chiller Outlet on MODBUS / Bacnet / Lonworks Open Protocol					√					BTU Meter provided by BAS Vendor, Installed by HVAC Vendor.
				Makeup water Tank										
	17			Water High Level										Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS Integration.
	18			Water Medium Level										
	18			Water Low Level										
	19			Makeup water Tank Isolation Valve Open / Close Status					√			√	√	
	20			Makeup water Tank Isolation Valve Open / Close CMD							√		√	
	Sub Total for Chiller Systems													
	Spare 15%													
	Total													
LOWER BASEMENT	B	Primary Pumps	4	Pump status(ON/OFF)								√	√	
	1		(3W+1S)	Pump Start/Stop Command						√			√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks /
	2			Pump trip status								√	√	
	3			Pump Auto / Manual switch status					√			√	√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	4			Common Return Temperature from System on Header							√	√		BACnet Output for BMS Integration.
	5			Supply Temperature To CHW							√	√	√	
	6			Pressure Sensor on supply header & Return headers							√	√	√	
	Sub Total for Primary Pumps													
	Spare 15%													
	Total													
LOWER BASEMENT	C	Secondary Pumps	8	Pump Start/Stop Command						√		√	√	
	1			Pump trip status								√	√	
	2			Pump status(ON/OFF)								√	√	
	3			Pump Auto / Manual switch status								√	√	
	4			VFD speed control								√	√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS Integration.
	5			VFD speed feedback								√	√	
	6			VFD error code					√			√		
	7			Secondary Chilled Water Supply Temperature for each loop							√	√	√	
	8			Diff.Pressure Sensor across supply & Return headers for VFD Modulation							√	√	√	
	9			Absolute Pressure Sensor at the Secondary Pump Outlet Header							√	√	√	
	Sub Total for Secondary Pumps													
	Spare 15%													
	Total													
LOWER BASEMENT	D	Condenser Water Pumps	7											
	1		(6W +1S)	Pumps ON / OFF command						√	√		√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS Integration.
	2			Pumps ON / OFF Status							√		√	
	3			Pumps Auto / Manual status					√		√		√	
	4			Pumps trip status							√	√	√	
	5			Water Pressure sensor on Expansion Tank							√	√	√	
	Sub Total for Condensor Water Pumps													
	Spare 15%													
	Total													
LOWER BASEMENT	E	AIR COOLED SCREW CHILLER WITH HEAT PUMP	3(2W +1S)											
	1			Chilled Water Supply Header Temp							√	√	√	
	2			Chilled Water Return Header Temp							√	√	√	
	3			Chilled Water Supply Header Pressure							√	√	√	
	4			Chilled Water Return Header Pressure							√	√	√	
	5			Chiller CHW Supply & Return Temp							√	√	√	
	6			Chilled Water Supply Temp Set point Reset						√			√	
	7			Chiller Start / Stop Command										
	8			CHW Flow Through Chiller Status (ON / OFF status)					√			√	√	
	9			Chiller Enable						√			√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS Integration.
	10			Chiller Auto / Manual Status								√	√	
	11			Chilled Supply Water Isolation Valve Open / Close Status								√	√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	12			Chilled Supply Water Isolation Valve Open / Close CMD							√		√	
	13			Condensor Retun Water Isolation Valve Open / Close Status								√	√	
	14			Condensor Retun Water Isolation Valve Open / Close CMD							√		√	
	13			Emergency Shut down								√	√	
				General Fault Alarm								√		
	14			Soft Integration with Chiller on MODBUS / Bacnet / Lonworks Open Protocol										
	15			Soft Integration with BTU Meter at Chiller Outlet on MODBUS / Bacnet / Lonworks Open Protocol					√					BTU Meter provided by BAS Vendor, Installed by HVAC Vendor.
				Hot water Well										
	16			Water High Level										
	17			Water Medium Level										
	17			Water Low Level										
	18			Hot water Well Isolation Valve Open / Close Status								√	√	
	19			Hot water Well Isolation Valve Open / Close CMD							√		√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS Integration.
									√					
				Warm water Well										
	20			Water High Level										
	21			Water Medium Level										
	21			Water Low Level										
	22			Warm water Well Isolation Valve Open / Close Status								√	√	
	23			Warm water Well Isolation Valve Open / Close CMD							√		√	
	Sub Total for Chiller Systems													
	Spare 15%													
	Total													
LOWER BASEMENT	F	Primary Hot Water Pumps	6	Pump status(ON/OFF)								√	√	
	1		(3W+1S)	Pump Start/Stop Command						√			√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS Integration.
	2			Pump trip status								√	√	
	3			Pump Auto / Manual switch status					√			√	√	
	4			Common Return Temperature from System on Header							√	√		
	5			Supply Temperature To CHW							√	√	√	
	6			Pressure Sensor on supply header & Return headers							√	√	√	
	Sub Total for DDC Panel													
	Spare 15%													
	Total													
LOWER BASEMENT	G	Secondary Hot Water Pumps	6	Pump Start/Stop Command						√		√	√	
	1		(3W+3S)	Pump trip status								√	√	
	2			Pump status(ON/OFF)								√	√	
	3			Pump Auto / Manual switch status								√	√	Chiller manager provided by Chiller Manufacturer to give Modbus / Lonworks / BACnet Output for BMS
	4			VFD speed control								√	√	
	5			VFD speed feedback					√			√	√	
	6			VFD error code								√		

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	7			Secondary Chilled Water Supply Temperature for each loop							√	√	√	Integration.
	8			Diff.Pressure Sensor across supply & Return headers for VFD Modulation							√	√	√	
	9			Absolute Pressure Sensor at the Secondary Pump Outlet Header							√	√	√	
	Sub Total for Secondary Pumps for Tower Riser				0	0	0	0						
	Spare 15%				0	0	0	0						
	Total				0	0	0	0						
LOWER BASEMENT	H	AHU's with VFDs & 10µ filter	2											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	16			Outside Air Temp / RH Sensor	1						√	√	√	Outside Air Temp / RH Sensor
	Sub Total				13	3	4	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				15	4	5	2						
	Total for 2 AHU unit				30	8	10	4						
Car Parking Ventilation														
LOWER BASEMENT	I	Exhaust Air Units	18											
	1			Fan ON / OFF Command				18		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			18				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			18				√	√	√	PF Contact at Starter Panel
	4			Fan working in Fire Mode			18						√	PF Contact at Starter Panel
	5			VFD speed control		18			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	6			VFD speed feedback								√	√	
	7			VFD error code								√	√	
LOWER BASEMENT	J	Fresh Air Units	10											
	1			Fan ON / OFF Command				10		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			10				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			10				√	√	√	PF Contact at Starter Panel
	4			Filter Status			10				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	Sub Total				0	18	84	28						
	Spare 15%				0	3	13	5						
	Total for Car Parking Ventilation				0	21	97	33						

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
Floor Ventilation														
LOWER BASEMENT	K	Exhaust Air Units	3											
	1			Fan ON / OFF Command				3		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			3				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			3				√	√	√	PF Contact at Starter Panel
LOWER BASEMENT	L	Fresh Air Units	3											
	1			Fan ON / OFF Command				3		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			3				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			3				√	√	√	PF Contact at Starter Panel
Sub Total					0	0	12	6						
Spare 15%					0	0	2	1						
Total for Floor Ventilation					0	0	14	7						
UPPER BASEMENT	A	AHU's with VFDs & 10μ filter	5											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring			5				√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
		Sub Total			12	3	9	1						
		Spare 15%			2	1	2	1						
		Total for 1 AHU unit			14	4	11	2						
		Total for 5 AHU unit			70	20	55	10						
UPPER BASEMENT	B	AHU's with VFDs & 5µ filter	21											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	5	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	6	2						
	Total for 21 AHU unit				294	84	126	42						
Car Parking Ventilation														
UPPER BASEMENT	C	Exhaust Air Units	3											
	1			Fan ON / OFF Command				3		√	√	√	√	PF Contact at Starter Panel

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	2			Fan on / OFF Status			3				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			3				√	√	√	PF Contact at Starter Panel
	4			Fan working in Fire Mode			3						√	PF Contact at Starter Panel
	5			VFD speed control		3			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	6			VFD speed feedback								√	√	
	7			VFD error code								√	√	
UPPER BASEMENT	D	Fresh Air Units	4											
	1			Fan ON / OFF Command				4		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			4				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	2			Fan Trip Status			4				√	√	√	PF Contact at Starter Panel
	2			Filter Status			4				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
Fan Starting in case of fire														
UPPER BASEMENT	E	Exhaust Air Units	3											
	1			Fan ON / OFF Command				3		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			3				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			3				√	√	√	PF Contact at Starter Panel
	Sub Total				0	3	27	10						
	Spare 15%				0	1	5	2						
	Total for Floor Ventilation				0	4	32	12						
UPPER BASEMENT	G	VAV Boxes												
	1		16	Room air temp measurement							√	√	√	By HVAC or VAV Vendor (Lonworks/ModBus / BACnet port at AHU Room at every floor & from AHU room to BMS by BMS Vendor)
	2			Damper Control CMD										
	3			Damper status									√	
	4			Air flow measurement					√		√	√	√	
	5			Air flow set point									√	
	6			Cooling load %age							√	√	√	
	7			Room air temperature set point									√	
Ground Floor	A	AHU's with VFDs & 10µ filter	4											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	Sub Total				12	3	4	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	5	2						
	Total for 6 AHU unit				56	16	20	8						
Ground Floor	B	AHU's with VFDs & 5µ filter	22											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	5	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	6	2						
	Total for 22 AHU unit				308	88	132	44						
Ground Floor	C	AHU's with VFDs & 0.3µ filter	6											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			3				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring			5				√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	11	1						
	Spare 15%				2	1	2	1						
	Total for 1 AHU unit				14	4	13	2						
	Total for 6 AHU unit				84	24	78	12						
Car Parking Ventilation														
Ground Floor	C	Exhaust Air Units	7											
	1			Fan ON / OFF Command				7		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			7				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			7				√	√	√	PF Contact at Starter Panel
	4			Fan working in Fire Mode			7						√	PF Contact at Starter Panel
	5			VFD speed control		7			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	6			VFD speed feedback								√	√	
	7			VFD error code								√	√	
Ground Floor	D	Fresh Air Units	8											
	1			Fan ON / OFF Command				8		√	√	√	√	PF Contact at Starter Panel

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	2			Fan on / OFF Status			8				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	2			Fan Trip Status			8				√	√	√	PF Contact at Starter Panel
	2			Filter Status			8				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
Fan Starting in case of fire														
Ground Floor	E	Exhaust Air Units	7											
	1			Fan ON / OFF Command				7		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			7				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			7				√	√	√	PF Contact at Starter Panel
Sub Total					0	7	59	22						
Spare 15%					0	2	9	4						
Total for Floor Ventilation					0	9	68	26						
Electrical :HT Panel /LT Panel /Transformer														
Ground Floor	F	Transformers	6	Winding Temperature	6						√	√	√	Temp sensor Supplied and installed by TransformerVendor
				Transformer Trouble			6				√	√	√	P F Contact in Marshalling Box by Transformer Vendor
			6	Breaker On/ Off Status			6				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			6				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
Ground Floor	G	HT Breakers	12	Breaker On/ Off Status			12				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			12				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
			2	Bus Coupler On/ Off Status			2				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Bus Coupler Trip Status			2				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
Ground Floor	H	Main LT panel 1 for PH 2	15	Breaker On/ Off Status			12				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			12				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
										√	√	√	√	P F contact in Panel by Electrical Vendor
			2	Bus Coupler On/ Off Status			2				√	√	√	P F Contact in Marshalling Box by Electrical Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
				Bus Coupler Trip Status			2				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
										√	√	√	√	P F contact in Panel by Electrical Vendor
Ground Floor	I	Main LT panel 2 for PH 1 & 2	14	Breaker On/ Off Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
										√	√	√	√	P F contact in Panel by Electrical Vendor
			2	Bus Coupler On/ Off Status			2				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Bus Coupler Trip Status			2				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
										√	√	√	√	P F contact in Panel by Electrical Vendor
Ground Floor	J	LOAD MANAGER	10	Line Voltage (each phase)					√		√	√	√	Modbus port provided by Electrical Vendor at each digital meter. Communication cabling from each digital meter to BMS by BMS Contractor
				Phase current (each phase)										
				Neutral Current										
				Frequency										
				Power Factor										
				Total harmonic distortion for each voltage										
				Total harmonic distortion for each current										
				Summation of kWh										
				Transformer kVA Reading										
Ground Floor	K	Sub LT panel 1	8	Breaker On/ Off Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
										√	√	√	√	P F contact in Panel by Electrical Vendor
Ground Floor	L	Sub LT panel 2	12	Breaker On/ Off Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
										√	√	√	√	P F contact in Panel by Electrical Vendor
Ground Floor	M	Sub LT panel 3	12	Breaker On/ Off Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			15				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
										√	√	√	√	P F contact in Panel by Electrical Vendor
Ground Floor	N	LOAD MANAGER	34	Line Voltage (each phase)					√		√	√	√	Modbus port provided by Electrical Vendor at each digital meter. Communication cabling
				Phase current (each phase)										
				Neutral Current										
				Frequency										
				Power Factor										

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
				Total harmonic distortion for each voltage										from each digital meter to BMS by BMS Contractor
				Total harmonic distortion for each current										
				Summation of kWh										
				Transformer kVA Reading										
Ground Floor	O	Auto-transfer switch Panel	9	ATS position					√		√	√	√	
				Load on Mains							√	√	√	
				Load on Generator							√		√	
				Mains Available							√	√	√	
				Generator Available							√	√	√	
Ground Floor	P	UPS Monitoring	5	Soft Integration with BMS on Lonworks / Modbus / Open Paltform					√		√	√	√	Protocol Integrator by BMS
				Breaker On/ Off Status			12				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			12				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
Ground Floor	Q	APFCR Monitoring	1	Soft Integration with BMS on Lonworks / Modbus / Open Paltform					√		√	√	√	Protocol Integrator by BMS
				Breaker On/ Off Status			4				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
				Breaker Trip Status			4				√	√	√	P F Contact in Marshalling Box by Electrical Vendor
		Sub Total			6	0	230	0						
		Spare 10%			1	0	23	0						
		Total for Electrical :HT Panel /LT Panel /Transformer			7	0	253	0						
Ground Floor	R	Generator Room												
		D G sets	6	DG Sets Soft integrationSoft Integration Modbus / Lonworks / Other Open Protocols					√					Protocol Integrator by BMS
		Sync. Panel for PH 2	1	DG Sets Soft integrationSoft Integration Modbus / Lonworks / Other Open Protocols					√					
		Breakers	9	Breaker On / Off Status			9				√	√	√	P F contact in Panel by Electrical Vendor
				Breaker Trip Status			9				√	√	√	P F contact in Panel by Electrical Vendor
											√	√	√	P F contact in Panel by Electrical Vendor
		Sync. Panel for PH 2 & PH 1	1	DG Sets Soft integrationSoft Integration Modbus / Lonworks / Other Open Protocols					√					Protocol Integrator by BMS
		Breakers	9	Breaker On / Off Status			9				√	√	√	P F contact in Panel by Electrical Vendor
				Breaker Trip Status			9				√	√	√	P F contact in Panel by Electrical Vendor
											√	√	√	P F contact in Panel by Electrical Vendor
Ground Floor	S	LOAD MANAGER	14	Line Voltage (each phase)										

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
				Phase current (each phase)										Modbus port provided by Electrical Vendor at each digital meter. Communication cabling from each digital meter to BMS by BMS Contractor
				Neutral Current										
				Frequency					√		√	√	√	
				Power Factor										
				Total harmonic distortion for each voltage										
				Total harmonic distortion for each current										
				Summation of kWh										
				Transformer kVA Reading										
		Sub Total			0	0	36	0						
		Spare 15%			0	0	6	0						
		Total for Generator			0	0	42	0						
Ground Floor	T	Auto-transfer switch Panel FFTG Pumps & Smoke Evacuation Fans	2	ATS position					√		√	√	√	
				Load on Mains							√	√	√	
				Load on Generator							√		√	
				Mains Available							√	√	√	
				Generator Available							√	√	√	
Ground Floor	U	Auto-transfer switch Panel for Lighting panel 1	22	ATS position					√		√	√	√	
				Load on Mains							√	√	√	
				Load on Generator							√		√	
				Mains Available							√	√	√	
				Generator Available							√	√	√	
Ground Floor	V	Auto-transfer switch Panel for Lighting panel 2	27	ATS position					√		√	√	√	
				Load on Mains										
				Load on Generator										
				Mains Available										
				Generator Available										
Ground Floor	W	Auto-transfer switch Panel for RAW Power panel 1	22	ATS position										
				Load on Mains										
				Load on Generator										
				Mains Available										
				Generator Available							√	√	√	
Ground Floor	X	Auto-transfer switch Panel for RAW Power panel 2	21	ATS position					√		√	√	√	
				Load on Mains							√	√	√	
				Load on Generator							√		√	
				Mains Available							√	√	√	
				Generator Available							√	√	√	
Ground Floor	Y	Auto-transfer switch Panel for UPS Power panel 1	22	ATS position										
				Load on Mains										

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
				Load on Generator										
				Mains Available										
				Generator Available										
Ground Floor	Z	Auto-transfer switch Panel for UPS Power panel 2	19	ATS position										
				Load on Mains										
				Load on Generator										
				Mains Available										
				Generator Available										
Ground Floor	AA	Auto-transfer switch Panel for AHU panel 1	9	ATS position										
				Load on Mains										
				Load on Generator										
				Mains Available										
				Generator Available										
Ground Floor	AB	Auto-transfer switch Panel for AHU panel 2	9	ATS position										
				Load on Mains										
				Load on Generator										
				Mains Available										
				Generator Available										
Ground Floor	AC	Auto-transfer switch Panel for AHU Sub panel (1 to 17)	17	ATS position										
				Load on Mains										
				Load on Generator										
				Mains Available										
				Generator Available										
First Floor	A	AHU's with VFDs & 10µ filter	4											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
		Sub Total			12	3	4	1						
		Spare 15%			2	1	1	1						
		Total for 1 AHU unit			14	4	5	2						
		Total for 4 AHU unit			56	16	20	8						
First Floor	B	AHU's with VFDs & 5µ filter	22											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	20			Water Pressure Sensor at inlet	1						√	√	√	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						√	√	√	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	5	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	6	2						
	Total for 22 AHU unit				308	88	132	44						
First Floor		TFA UNITS	1											
	1			TFA SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
	2			TFA SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
	3			TFA SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
	4			TFA RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
	5			TFA RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
	6			TFA RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
	7			TFA Wheel ON/OFF Command				2		√			√	PF contact to Starter panel
	8			TFA Wheel ON/OFF Status			2					√	√	PF contact from Starter panel
	9			TFA wheel Auto/Manual status			1					√	√	PF contact from Starter panel
	10			Supply Air Temperature and Rh leaving Wheel	2						√	√	√	Duct type T+RH sensor
	11			Return Air Temperature & RH Entering Wheel	2						√	√	√	Duct type T+RH sensor
	12			Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
	13			TFA supply and exhaust status			2					√	√	PF contact from Starter panel
	14			VFD speed control		2			√			√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	15			VFD speed feedback								√	√	
	16			VFD error code								√	√	
	17			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	18			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	19			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	20			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	Sub Total				6	3	10	5						
	Spare 15%				1	1	2	1						

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	Total for 1 TFA				7	4	12	6						
					7	4	12	6						
1st Floor		HRU UNITS	1											
1				HRU SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
2				HRU SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
3				HRU SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
4				HRU RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
5				HRU RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
6				HRU RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
7				HRU Wheel ON/OFF Command				1		√			√	PF contact to Starter panel
8				HRU Wheel ON/OFF Status			1					√	√	PF contact from Starter panel
9				HRU wheel Auto/Manual status			1					√	√	PF contact from Starter panel
10				Supply Air Temperature and Rh leaving Wheel	1						√	√	√	Duct type T+RH sensor
11				Return Air Temperature & RH Entering Wheel	1						√	√	√	Duct type T+RH sensor
12				Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
13				HRU supply and exhaust status			2					√	√	PF contact from Starter panel
14				VFD speed control		1			√	√		√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
15				VFD speed feedback								√	√	
16				VFD error code								√	√	
17				Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor
18				Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor
19				Chilled water valve open/Close command				2						Supply & Installation of valve with actuator of 2 Way Valve shall be done by HVAC Vendor scope controlled by BAS
				Sub Total for 1 Unit	4	1	9	6						
				Spare 10%	1	1	1	1						
				Total	5	2	10	7						
				Total HRU for 1 nos	5	2	10	7						
First Floor	G	VAV Boxes												
	1		52	Room air temp measurement							√	√	√	By HVAC or VAV Vendor (Lonworks/ModBus / BACnet port at AHU Room at every floor & from AHU room to BMS by BMS Vendor)
	2			Damper Control CMD										
	3			Damper status									√	
	4			Air flow measurement					√		√	√	√	
	5			Air flow set point									√	
	6			Cooling load %age							√	√	√	
	7			Room air temperature set point									√	
Second Floor	A	AHU's with VFDs & 10µ filter	4											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	20			Water Pressure Sensor at inlet	1						√	√	√	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						√	√	√	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	4	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	5	2						
	Total for 4 AHU unit				56	16	20	8						
Second Floor	B	AHU's with VFDs & 5µ filter	19											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
		Sub Total			12	3	5	1						
		Spare 15%			2	1	1	1						
		Total for 1 AHU unit			14	4	6	2						
		Total for 19 AHU unit			266	76	114	38						
Second Floor	C	AHU's with VFDs & 0.3µ filter	8											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			3				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
		Sub Total			12	3	6	1						
		Spare 15%			2	1	1	1						
		Total for 1 AHU unit			14	4	7	2						
		Total for 8 AHU unit			112	32	56	16						
Second Floor		TFA UNITS	1											
	1			TFA SUPPLY AIR FAN ON/OFF Command				1		**√**			**√**	PF contact to Starter panel
	2			TFA SUPPLY AIR FAN ON/OFF Status			1					**√**	**√**	DP Switch Across FAN
	3			TFA SUPPLY AIR FAN Auto/Manual status				1				**√**	**√**	PF contact from Starter panel
	4			TFA RETURN AIR FAN ON/OFF Command			1			**√**			**√**	PF contact to Starter panel
	5			TFA RETURN AIR FAN ON/OFF Status				1				**√**	**√**	DP Switch Across FAN
	6			TFA RETURN Auto/Manual STATUS			1					**√**	**√**	PF contact from Starter panel

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	7			TFA Wheel ON/OFF Command				2		√			√	PF contact to Starter panel
	8			TFA Wheel ON/OFF Status			2					√	√	PF contact from Starter panel
	9			TFA wheel Auto/Manual status			1					√	√	PF contact from Starter panel
	10			Supply Air Temperature and Rh leaving Wheel	2						√	√	√	Duct type T+RH sensor
	11			Return Air Temperature & RH Entering Wheel	2						√	√	√	Duct type T+RH sensor
	12			Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
	13			TFA supply and exhaust status			2					√	√	PF contact from Starter panel
	14			VFD speed control		2			√			√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	15			VFD speed feedback								√	√	
	16			VFD error code								√	√	
	17			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	18			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	19			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	20			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	Sub Total				6	3	10	5						
	Spare 15%				1	1	2	1						
	Total for 1 TFA				7	4	12	6						
Second Floor		HRU UNITS	2											
1				HRU SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
2				HRU SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
3				HRU SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
4				HRU RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
5				HRU RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
6				HRU RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
7				HRU Wheel ON/OFF Command				1		√			√	PF contact to Starter panel
8				HRU Wheel ON/OFF Status			1					√	√	PF contact from Starter panel
9				HRU wheel Auto/Manual status			1					√	√	PF contact from Starter panel
10				Supply Air Temperature and Rh leaving Wheel	1						√	√	√	Duct type T+RH sensor
11				Return Air Temperature & RH Entering Wheel	1						√	√	√	Duct type T+RH sensor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
12				Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
13				HRU supply and exhaust status			2					√	√	PF contact from Starter panel
14				VFD speed control		1			√	√		√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
15				VFD speed feedback								√	√	
16				VFD error code								√	√	
17				Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor
18				Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor
19				Chilled water valve open/Close command				2						Supply & Installation of valve with actuator of 2 Way Valve shall be done by HVAC Vendor scope controlled by BAS
				Sub Total for 1 Unit	4	1	9	6						
				Spare 10%	1	1	1	1						
				Total	5	2	10	7						
				Total HRU for 2 nos	10	4	20	14						
Second Floor	G	VAV Boxes												
	1		70	Room air temp measurement							√	√	√	By HVAC or VAV Vendor (Lonworks/ModBus / BACnet port at AHU Room at every floor & from AHU room to BMS by BMS Vendor)
	2			Damper Control CMD										
	3			Damper status									√	
	4			Air flow measurement					√		√	√	√	
	5			Air flow set point									√	
	6			Cooling load %age							√	√	√	
	7			Room air temperature set point									√	
Third Floor	A	AHU's with VFDs & 10µ filter	2											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
		Sub Total			12	3	4	1						
		Spare 15%			2	1	1	1						
		Total for 1 AHU unit			14	4	5	2						
		Total for 2 AHU unit			28	8	10	4						
Third Floor	B	AHU's with VFDs & 5µ filter	15											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	Sub Total				12	3	5	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	6	2						
	Total for 15 AHU unit				210	60	90	30						
Third Floor	C	AHU's with VFDs & 0.3µ filter	4											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			3				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
				Sub Total	12	3	6	1						
				Spare 15%	2	1	1	1						
				Total for 1 AHU unit	14	4	7	2						
				Total for 4 AHU unit	56	16	28	8						
Third Floor		TFA UNITS	1											
	1			TFA SUPPLY AIR FAN ON/OFF Command				1		**√**			**√**	PF contact to Starter panel
	2			TFA SUPPLY AIR FAN ON/OFF Status			1					**√**	**√**	DP Switch Across FAN
	3			TFA SUPPLY AIR FAN Auto/Manual status				1				**√**	**√**	PF contact from Starter panel
	4			TFA RETURN AIR FAN ON/OFF Command			1			**√**			**√**	PF contact to Starter panel
	5			TFA RETURN AIR FAN ON/OFF Status				1				**√**	**√**	DP Switch Across FAN
	6			TFA RETURN Auto/Manual STATUS			1					**√**	**√**	PF contact from Starter panel
	7			TFA Wheel ON/OFF Command				2		**√**			**√**	PF contact to Starter panel
	8			TFA Wheel ON/OFF Status			2					**√**	**√**	PF contact from Starter panel
	9			TFA wheel Auto/Manual status			1					**√**	**√**	PF contact from Starter panel
	10			Supply Air Temperature and Rh leaving Wheel	2						**√**	**√**	**√**	Duct type T+RH sensor
	11			Return Air Temperature & RH Entering Wheel	2						**√**	**√**	**√**	Duct type T+RH sensor
	12			Filter status on air entering wheel & air entering conditioned space			2					**√**	**√**	Air DP Switch Across Filter
	13			TFA supply and exhaust status			2					**√**	**√**	PF contact from Starter panel
	14			VFD speed control		2			**√**			**√**	**√**	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	15			VFD speed feedback								**√**	**√**	
	16			VFD error code								**√**	**√**	
	17			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	18			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	19			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	20			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	Sub Total				6	3	10	5						
	Spare 15%				1	1	2	1						
	Total for 1 TFA				7	4	12	6						
Third Floor		HRU UNITS	3											
1				HRU SUPPLY AIR FAN ON/OFF Command				1		**√**			**√**	PF contact to Starter panel
2				HRU SUPPLY AIR FAN ON/OFF Status			1					**√**	**√**	DP Switch Across FAN
3				HRU SUPPLY AIR FAN Auto/Manual status				1				**√**	**√**	PF contact from Starter panel
4				HRU RETURN AIR FAN ON/OFF Command			1			**√**			**√**	PF contact to Starter panel
5				HRU RETURN AIR FAN ON/OFF Status				1				**√**	**√**	DP Switch Across FAN
6				HRU RETURN Auto/Manual STATUS			1					**√**	**√**	PF contact from Starter panel
7				HRU Wheel ON/OFF Command				1		**√**			**√**	PF contact to Starter panel
8				HRU Wheel ON/OFF Status			1					**√**	**√**	PF contact from Starter panel
9				HRU wheel Auto/Manual status			1					**√**	**√**	PF contact from Starter panel
10				Supply Air Temperature and Rh leaving Wheel	1						**√**	**√**	**√**	Duct type T+RH sensor
11				Return Air Temperature & RH Entering Wheel	1						**√**	**√**	**√**	Duct type T+RH sensor
12				Filter status on air entering wheel & air entering conditioned space			2					**√**	**√**	Air DP Switch Across Filter
13				HRU supply and exhaust status			2					**√**	**√**	PF contact from Starter panel
14				VFD speed control		1			**√**	**√**		**√**	**√**	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
15				VFD speed feedback								**√**	**√**	
16				VFD error code								**√**	**√**	
17				Chilled Water Supply Temp	1						**√**	**√**	**√**	Immersion Temp Sensor
18				Chilled Water Return Temp	1						**√**	**√**	**√**	Immersion Temp Sensor
19				Chilled water valve open/Close command				2						Supply & Installation of valve with actuator of 2 Way Valve shall be done by HVAC Vendor scope controlled by BAS
Sub Total for 1 Unit					4	1	9	6						
Spare 10%					1	1	1	1						
Total					5	2	10	7						
Total HRU for 3 nos					15	6	30	21						
Third Floor	G	VAV Boxes												
	1		56	Room air temp measurement							√	√	√	By HVAC or VAV Vendor (Lonworks/ModBus / BACnet port at AHU Room at every floor & from AHU room to BMS by BMS Vendor)
	2			Damper Control CMD										
	3			Damper status									√	
	4			Air flow measurement					√		√	√	√	
	5			Air flow set point									√	
	6			Cooling load %age							√	√	√	
	7			Room air temperature set point									√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
Vivarium Block Terrace	C	Cooling tower	7											
	1		(6 W +1S)	Condenser Water Return Temp					√		√	√	√	Chiller manager provided by Chiller Manufacturer.
	2			Condenser Water Supply Temp							√	√	√	
	3			Fan Status								√	√	
	4			Fan Start/Stop CMD						√			√	
	5			VFD speed control						√		√	√	
	6			VFD speed feedback								√	√	
	7			VFD error code							√	√	√	
	8			Outlet & Inlet condenser water temperature (Header)							√	√	√	
	9			Basin temperature sensing							√	√	√	
				Cooling tower Basin										
	1			Level Switch - High								√	√	
	2			Level Switch - Low								√	√	
				cooling tower makeup water valve % open command						√	√	√	√	
		Sub Total												
		Spare 15%												
		Total for 1 No. Cooling tower												
		Total for 7 Cooling tower												
Fourth Floor	A	AHU's with VFDs & 10µ filter	1											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	4	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	5	2						
	Total for 1 AHU unit				14	4	5	2						
Fourth Floor	B	AHU's with VFDs & 5µ filter	12											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	5	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	6	2						
	Total for 12 AHU unit				168	48	72	24						

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
Fourth Floor		TFA UNITS	2											
	1			TFA SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
	2			TFA SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
	3			TFA SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
	4			TFA RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
	5			TFA RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
	6			TFA RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
	7			TFA Wheel ON/OFF Command				2		√			√	PF contact to Starter panel
	8			TFA Wheel ON/OFF Status			2					√	√	PF contact from Starter panel
	9			TFA wheel Auto/Manual status			1					√	√	PF contact from Starter panel
	10			Supply Air Temperature and Rh leaving Wheel	2						√	√	√	Duct type T+RH sensor
	11			Return Air Temperature & RH Entering Wheel	2						√	√	√	Duct type T+RH sensor
	12			Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
	13			TFA supply and exhaust status			2					√	√	PF contact from Starter panel
	14			VFD speed control		2			√			√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	15			VFD speed feedback								√	√	
	16			VFD error code								√	√	
	17			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	18			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	19			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	20			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	Sub Total				6	3	10	5						
	Spare 15%				1	1	2	1						
	Total for 1 TFA				7	4	12	6						
	Total for 2 TFA				14	8	24	12						
Forth Floor		HRU UNITS	3											
1				HRU SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
2				HRU SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
3				HRU SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
4				HRU RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
5				HRU RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
6				HRU RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
7				HRU Wheel ON/OFF Command				1		√			√	PF contact to Starter panel
8				HRU Wheel ON/OFF Status			1					√	√	PF contact from Starter panel
9				HRU wheel Auto/Manual status			1					√	√	PF contact from Starter panel
10				Supply Air Temperature and Rh leaving Wheel	1						√	√	√	Duct type T+RH sensor
11				Return Air Temperature & RH Entering Wheel	1						√	√	√	Duct type T+RH sensor
12				Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
13				HRU supply and exhaust status			2					√	√	PF contact from Starter panel
14				VFD speed control		1			√	√		√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
15				VFD speed feedback								√	√	
16				VFD error code								√	√	
17				Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor
18				Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor
19				Chilled water valve open/Close command				2						Supply & Installation of valve with actuator of 2 Way Valve shall be done by HVAC Vendor scope controlled by BAS
				Sub Total for 1 Unit	4	1	9	6						
				Spare 10%	1	1	1	1						
				Total	5	2	10	7						
				Total HRU for 3 nos	15	6	30	21						
Fourth Floor	G	VAV Boxes												
	1		68	Room air temp measurement							√	√	√	By HVAC or VAV Vendor (Lonworks/ModBus / BACnet port at AHU Room at every floor & from AHU room to BMS by BMS Vendor)
	2			Damper Control CMD										
	3			Damper status									√	
	4			Air flow measurement					√		√	√	√	
	5			Air flow set point									√	
	6			Cooling load %age							√	√	√	
	7			Room air temperature set point									√	
Fifth Floor	A	AHU's with VFDs & 10µ filter	2											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	4	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	5	2						
	Total for 2 AHU unit				28	8	10	4						

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
Fifth Floor	B	AHU's with VFDs & 5µ filter	9											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						√	√	√	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						√	√	√	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
				Sub Total	12	3	5	1						
				Spare 15%	2	1	1	1						
				Total for 1 AHU unit	14	4	6	2						
				Total for 9 AHU unit	126	36	54	18						
Fifth Floor		TFA UNITS	2											
	1			TFA SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
	2			TFA SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
	3			TFA SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
	4			TFA RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
	5			TFA RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
	6			TFA RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
	7			TFA Wheel ON/OFF Command				2		√			√	PF contact to Starter panel
	8			TFA Wheel ON/OFF Status			2					√	√	PF contact from Starter panel
	9			TFA wheel Auto/Manual status			1					√	√	PF contact from Starter panel
	10			Supply Air Temperature and Rh leaving Wheel	2						√	√	√	Duct type T+RH sensor
	11			Return Air Temperature & RH Entering Wheel	2						√	√	√	Duct type T+RH sensor
	12			Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
	13			TFA supply and exhaust status			2					√	√	PF contact from Starter panel
	14			VFD speed control		2			√			√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	15			VFD speed feedback								√	√	
	16			VFD error code								√	√	
	17			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	18			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	19			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	20			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	Sub Total				6	3	10	5						
	Spare 15%				1	1	2	1						
	Total for 1 TFA				7	4	12	6						
	Total for 2 TFA				14	8	24	12						
Fifth Floor		HRU UNITS	2											
1				HRU SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
2				HRU SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
3				HRU SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
4				HRU RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
5				HRU RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
6				HRU RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
7				HRU Wheel ON/OFF Command				1		√			√	PF contact to Starter panel
8				HRU Wheel ON/OFF Status			1					√	√	PF contact from Starter panel
9				HRU wheel Auto/Manual status			1					√	√	PF contact from Starter panel
10				Supply Air Temperature and Rh leaving Wheel	1						√	√	√	Duct type T+RH sensor
11				Return Air Temperature & RH Entering Wheel	1						√	√	√	Duct type T+RH sensor
12				Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
13				HRU supply and exhaust status			2					√	√	PF contact from Starter panel
14				VFD speed control		1			√	√		√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
15				VFD speed feedback								√	√	
16				VFD error code								√	√	
17				Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor
18				Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor
19				Chilled water valve open/Close command				2						Supply & Installation of valve with actuator of 2 Way Valve shall be done by HVAC Vendor scope controlled by BAS
				Sub Total for 1 Unit	4	1	9	6						
				Spare 10%	1	1	1	1						
				Total	5	2	10	7						
				Total HRU for 2 nos	10	4	20	14						
Fifth Floor	G	VAV Boxes												
	1		58	Room air temp measurement							√	√	√	By HVAC or VAV Vendor (Lonworks/ModBus / BACnet port at AHU Room at every floor & from AHU room to BMS by BMS Vendor)
	2			Damper Control CMD										
	3			Damper status									√	
	4			Air flow measurement					√		√	√	√	
	5			Air flow set point									√	
	6			Cooling load %age							√	√	√	
	7			Room air temperature set point									√	
Terrace														
Floor Ventilation														
Terrace	A	Exhaust Air Units	29											

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	1			Fan ON / OFF Command				29		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			29				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			29				√	√	√	PF Contact at Starter Panel
Terrace	B	Fresh Air Units	13											
	1			Fan ON / OFF Command				13		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			13				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			13				√	√	√	PF Contact at Starter Panel
	4			Filter Status			13				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
		Sub Total			0	0	97	42						
		Spare 15%			0	0	15	7						
		Total for Floor Ventilation			0	0	112	49						
Terrace	C	Staricase Pressurisation units	8											
	1			Fan ON / OFF Command							√	√	√	To be commanded by Fire Detection System
	2			Fan on / OFF Status			8				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			8				√	√	√	PF Contact at Starter Panel
	4			Fire Damper Monitoring			23				√	√	√	PF contact at Smoke Shutter & Fire Damper Terminal Box by HVAC vendor
Terrace	D	Smoke Exhaust Fan	16											
	7			Smoke Extraction Axial Fan On / Off Command				16						PF Contact in Starter Panel
	8			Smpoke Extraction Fan On / Off Status			16							Air DP Switch Across Fan , Supplied and Installed by BMS Vendor
	9			Fresh Air Axial FanTrip Status			16							PF Contact in Starter Panel
				Fire Damper Monitoring			55				√	√	√	PF contact at Smoke Shutter & Fire Damper Terminal Box by HVAC vendor
Terrace	D	Smoke Fresh Fan	10											
	7			Fresh air Fan On / Off Command				10						PF Contact in Starter Panel
	8			Fresh air Fan On / Off Status			10							Air DP Switch Across Fan , Supplied and Installed by BMS Vendor
	9			Fresh Air Axial FanTrip Status			10							PF Contact in Starter Panel

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
				Fire Damper Monitoring			55				√	√	√	PF contact at Smoke Shutter & Fire Damper Terminal Box by HVAC vendor
Terrace	E	LIFT & LIFT LOBBY PRESSURIZATION UNITS	14											
	1			Fan ON / OFF Command							√	√	√	To be commanded by Fire Detection System
	2			Fan on / OFF Status			14				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			14				√	√	√	PF Contact at Starter Panel
	4			Fire Damper Monitoring			14				√	√	√	PF contact at Smoke Shutter & Fire Damper Terminal Box by HVAC vendor
			Sub Total		0	0	243	26						
			Spare 15%		0	0	37	4						
			Total for Floor Ventilation		0	0	280	30						
Terrace	F	TFA UNITS	2											
	1			TFA SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
	2			TFA SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
	3			TFA SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
	4			TFA RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
	5			TFA RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
	6			TFA RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
	7			TFA Wheel ON/OFF Command				2		√			√	PF contact to Starter panel
	8			TFA Wheel ON/OFF Status			2					√	√	PF contact from Starter panel
	9			TFA wheel Auto/Manual status			1					√	√	PF contact from Starter panel
	10			Supply Air Temperature and Rh leaving Wheel	2						√	√	√	Duct type T+RH sensor
	11			Return Air Temperature & RH Entering Wheel	2						√	√	√	Duct type T+RH sensor
	12			Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
	13			TFA supply and exhaust status			2					√	√	PF contact from Starter panel
	14			VFD speed control		2			√			√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	15			VFD speed feedback								√	√	
	16			VFD error code								√	√	
	17			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	18			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	19			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	20			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	Sub Total				6	3	10	5						
	Spare 15%				1	1	2	1						
	Total for 1 TFA				7	4	12	6						
	Total for 2 TFA				14	8	24	12						
Fifth Floor		HRU UNITS	8											
1				HRU SUPPLY AIR FAN ON/OFF Command				1		√			√	PF contact to Starter panel
2				HRU SUPPLY AIR FAN ON/OFF Status			1					√	√	DP Switch Across FAN
3				HRU SUPPLY AIR FAN Auto/Manual status				1				√	√	PF contact from Starter panel
4				HRU RETURN AIR FAN ON/OFF Command			1			√			√	PF contact to Starter panel
5				HRU RETURN AIR FAN ON/OFF Status				1				√	√	DP Switch Across FAN
6				HRU RETURN Auto/Manual STATUS			1					√	√	PF contact from Starter panel
7				HRU Wheel ON/OFF Command				1		√			√	PF contact to Starter panel
8				HRU Wheel ON/OFF Status			1					√	√	PF contact from Starter panel
9				HRU wheel Auto/Manual status			1					√	√	PF contact from Starter panel
10				Supply Air Temperature and Rh leaving Wheel	1						√	√	√	Duct type T+RH sensor
11				Return Air Temperature & RH Entering Wheel	1						√	√	√	Duct type T+RH sensor
12				Filter status on air entering wheel & air entering conditioned space			2					√	√	Air DP Switch Across Filter
13				HRU supply and exhaust status			2					√	√	PF contact from Starter panel
14				VFD speed control		1			√	√		√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
15				VFD speed feedback								√	√	
16				VFD error code								√	√	
17				Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor
18				Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor
19				Chilled water valve open/Close command				2						Supply & Installation of valve with actuator of 2 Way Valve shall be done by HVAC Vendor scope controlled by BAS
				Sub Total for 1 Unit	4	1	9	6						
				Spare 10%	1	1	1	1						
				Total	5	2	10	7						
				Total HRU for 8 nos	40	16	80	56						
		Fire Damper Monitoring												
				Fire Damper Monitoring for Vivarium Block			130				√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
				Fire Damper Monitoring for Acadamic Block			35				√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
				Fire Damper Monitoring for Clinical Block			354				√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	Sub Total				0	0	354	0						
	Spare 15%				0	0	54	0						
	Total for 1 Critical Area t+Rh sensing				0	0	408	0						
	Toilet Ventilation													
Vivarium Block	A	Exhaust Air Units	2											
	1			Fan ON / OFF Command				2		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			2				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			2				√	√	√	PF Contact at Starter Panel
	4												√	PF Contact at Starter Panel
	B	Fresh Air Units	4											
	1			Fan ON / OFF Command				4		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			4				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	2			Fan Trip Status			4				√	√	√	PF Contact at Starter Panel
	2			Filter Status			4				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
Clinical Block	A	Exhaust Air Units	2											
	1			Fan ON / OFF Command				2		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			2				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			2				√	√	√	PF Contact at Starter Panel
	4												√	PF Contact at Starter Panel
	B	Fresh Air Units	2											
	1			Fan ON / OFF Command				2		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			2				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	2			Fan Trip Status			2				√	√	√	PF Contact at Starter Panel
	2			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
Acadamic Block	A	Exhaust Air Units	1											
	1			Fan ON / OFF Command				1		√	√	√	√	PF Contact at Starter Panel

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	2			Fan on / OFF Status			1				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	3			Fan Trip Status			1				√	√	√	PF Contact at Starter Panel
	4												√	PF Contact at Starter Panel
	B	Fresh Air Units	1											
	1			Fan ON / OFF Command				1		√	√	√	√	PF Contact at Starter Panel
	2			Fan on / OFF Status			1				√	√	√	Air DP Switch supplied and Installed by BMS Contractor
	2			Fan Trip Status			1				√	√	√	PF Contact at Starter Panel
	2			Filter Status			1				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	Sub Total				0	0	31	12						
	Spare 15%				0	0	5	2						
	Total for 1 Critical Area t+Rh sensing				0	0	36	14						
		Critical Area t+Rh sensing												
	1		10	Room air t +Rh measurement	10						√	√	√	Space type T+RH sensor
	Sub Total				10	0	0	0						
	Spare 15%				2	0	0	0						
	Total for 1 Critical Area t+Rh sensing				12	0	0	0						
Kitchen block	B	AHU's with VFDs	7											
	1			AHU start/stop command				1		√	√	√		PF Contact IN starter Panel By HVAC Vendor
	2			VFD speed control		1			√		√	√	√	VFD Supplied by HVAC (PF points at every AHU Room & from AHU room to BMS by BMS Vendor)
	3			VFD speed feedback								√	√	
	4			VFD error code								√	√	
	5			Supply air duct static pressure	1						√	√	√	Air DP Sensor supplied BY BMS, installed by BMS Vendor
	6			Supply air duct pressure set point									√	
	7			AHU on/off status (via DP switch)			1			√	√		√	DP Switch Across FAN supplied BY BMS, installed by BMS Vendor
	8			Switch mode (VFD / bypass)			1						√	PF Contact IN starter Panel By HVAC Vendor
	9			Return air temperature /humidity Monitoring	2						√	√	√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	10			Supply air temperature /humidity Monitoring	2						√		√	Duct type T+RH sensor supplied BY BMS, installed by BMS Vendor
	11			Supply air temperature set point									√	

Floor	Sr	Equipment / System / Area	Qty of Equipment	Description	Hardware Points				Soft Integration	Schedule	Trend	Alarm	Show On Graphic	Field Devices and Wiring to Interface Terminal Board
					AI	AO	DI	DO						Remarks
	12			Chilled Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	13			Chilled Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	14			Chilled water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	15			Hot Water Supply Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	16			Hot Water Return Temp	1						√	√	√	Immersion Temp Sensor supplied by BMS Vendor, installed by HVAC Vendor
	17			Hot water valve % open command		1				√	√	√	√	2 Way moterised valve Supply and Installation by HVAC Vendor
	18			Filter Status			2				√	√	√	DP Switch Across Filter supplied BY BMS, installed by BMS Vendor
	19			Motor overload trip			1					√	√	PF Contact from Starter Panel
	20			Fire alarm interlock							√	√	√	FAS on Soft Platform
	18			CO2 Sensor for Air Quality Measuring	1						√	√	√	CO2 Sensor
	19			Fire Damper Monitoring							√	√	√	PF contact at Fire Damper Terminal Box by HVAC vendor
	20			Water Pressure Sensor at inlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	21			Water Pressure Sensor at Outlet	1						**√**	**√**	**√**	Liq Water Pressure Sensor supplied by BMS, installed by HVAC vendor
	Sub Total				12	3	5	1						
	Spare 15%				2	1	1	1						
	Total for 1 AHU unit				14	4	6	2						
	Total for 7 AHU unit				98	28	42	14						

SPECIAL SPECIFICATIONS

FOR

FIRE FIGHTING WORKS

INDEX

SECTION. NO.	DESCRIPTION	PAGE NO.
1	GENERAL REQUIREMENT	2
2	FIRE PUMPS AND ACCESSORIES	3
3	FIRE HYDRANT SYSTEM	8
4	SPRINKLER SYSTEM (INTERNAL ONLY	22
5	COMMISSIONING OF FIRE FIGHTING SYSTEM	28
6	HAND APPLIANCES	31
7	GAS FLOODING SYSTEM	33
8	ELECTRICAL INSTALLATIONS	38
ANNEXURE -A	LIST OF APPROVED VENDORS FOR FIRE FIGHTING WORKS	42

SECTION – 1 GENERAL REQUIREMENT

1.0 Scope of work:

1.1 Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the **Fire Fighting** excluding Intern's & Nurse's Hostel Block and other specialized services as described hereinafter and as specified in the schedule of quantities and/or shown on the Fire Fighting drawings.

1.2 Without restricting to the generality of the foregoing the work shall include the following:

Fire Fighting Works includes:

i) Fire Pumps:

- Complete fire pumping system for phase-I & phase-II including all accessories and related Electrical works.

ii) Fire Hydrant System:

- Complete fire hydrant system including M.S. piping network, landing valve, hose reel, fire extinguishers, signage etc.

iii) Automatic Sprinkler System

- Complete automatic sprinkler system including M.S. piping network, sprinkler head, installation control valve etc.
- Test drain assembly, including orifice plate, flow switch and control wiring from flow switch to control panels.

iv) External Fire Hydrant System:

- Complete External Fire Hydrant System including piping, External Hydrant, Fire Brigade Connection etc.

v) Dismantling of Existing Fire Pumping System:

- Complete dismantling of existing fire pumping system including all accessories and related works in phase-I.

vi) Water Curtain System:

- Complete water curtain system for basements including water curtain pumps , deludge valve and nozzles etc. for phase-II only.

vii) Gas Flooding System

END SECTION – 1
GENERAL REQUIREMENTS

SECTION – 2 FIRE PUMPS AND ACCESSORIES

1.0 SCOPE:

1.1 Contractor shall furnish all labour, materials, equipment for supply, installation testing and commissioning of complete fire hydrant and sprinkler pumping system. In general, the item of works shall include but not limited to the following:

a) Electrically operated hydrant and sprinkler pumps, diesel engine driven pump and jockey pump.

b) Black steel M.S. (heavy) class `C' pipes for fire protection system including fittings, valves, accessories etc.

c) Internal and external fire hydrants, including valve chambers, fire brigade inlet connections, air cushion tanks with air release valves, M.S. hose box for Internal and External fire hydrants.

d) Sprinkler system including piping, flow switches, installation valve, and sprinkler heads etc.

2.0 PUMPS:

Fire and Jockey Pumps (Electric Driven)

Contractor shall provide and install electrically operated/diesel engine driven fire pumps of capacity and head indicated in the Drawings/Bill of Quantities

Pumping sets shall be single/multi stage horizontal centrifugal single or multi outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease-lubricated bearings mounted on common M.S. base frame.

Pumps shall be connected to the drive by means of tyre type coupling which shall be individually balanced dynamically and statically.

The coupling joins the prime mover with the pump shall be provided with a sheet metal guard.

Pumps shall be provided with approved type of mechanical seals.

Motors for Electric Driven Pumps

Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. The motor shall have class `**H'** insulation.

Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

Motors for fire pumps shall meet all requirements and specifications of the BIS standard and codes.

Diesel Engine:

Engine Rating:
The Diesel Engine shall be of approved make having bare engine horse power rating (after correction for attitude and ambient temperature) equivalent to the higher of the following two values:

a) 20% in excess of the maximum brake horsepower required to drive the pump at its duty point.

b) The brake horsepower required to drive the pump at 150% of its rated discharge.

The engine shall be complete with cooling mechanism, air-filtration, exhaust system (insulated exhaust pipe will be paid separately), shut down mechanism, fuel tank, starting mechanism, batteries, battery chargers, ancillary equipment, tools kit, spare parts and all other accessories to complete the work.

Engine Cooling:

The following systems are acceptable:

a) Cooling by water from the discharge of fire pump (taken off prior to the pump discharge valve) direct into the engine cylinder jackets via a pressure reducing device to limit the applied pressure to a safe value as specified by the engine manufacturer. The outlet connection from this system shall terminate at least 150mm above the engine water outlet pipe and be directed into an open tundish so that the discharge water is visible.

b) A heat exchanger, the cooling water being supplied from the pump discharge (taken prior to the pump discharge valve) via a pressure reducing device, if necessary to limit the applied pressure to a safe valve as specified by the engine manufacturer. The water outlet connection from this system shall be so designed that the discharged water can be readily observed.

Fuel Tank:

The fuel tank shall be of welded steel constructed to relevant Indian Standard for M.S. drums. The tank shall be mounted above the engine fuel pump to provide gravity feed. The tank shall be fitted with an indicator showing the level of the fuel in the tank. The capacity of tank shall be sufficient to allow the engine to run on full load for 6 hours.

Diesel Engine Exhaust System:

The Diesel Engine exhaust system shall be provided with 100mm dia insulated pipe.

Air Vessel for Fire Pumps

Provide on air vessel fabricated from 10mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 25mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. the vessel shall be 450mmx2000mm dia high and tested to **20**Kg/Sq.cm pressure.

The fire pumps shall operate on drop of 1 Kg/Sq.cm pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

2.1 Construction:

Pumps shall be as per IS:1520-1660, IS:9079, IS:325 and shall be of following construction:

Pump and driver shall be mounted on a single bed-plate and directly driven through flexible coupling in case of horizontal split casing pumps.

The pumps shall be of the type approved and capable of delivering not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head of pump shall not exceed 120% of the rated head. The drive motor shall be continuous rating type and its rating shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge.

S.NO.	PUMP DESCRIPTION	HORIZONTAL SPLIT CASING
1.	Casing	Cast Iron/Cast Steel
2.	Impeller	Bronze
3.	Shaft	High Tensile Steel
4.	Bearings	Heavy Duty Ball/Roller Bearings
5.	Base Plate	Fabricated M.S./Cast Iron
6.	Flanges	Conforming to IS:1536/1960
7.	Packing	Gland Packing
8.	Max. Speed	1500 RPM
9.	Driver	TEFC/SPDP
10.	Starter	Direct on Line

3.0 ACCESSORIES AND FITTINGS:

The following accessories shall be provided with each pump among other standard accessories required:

a) Coupling guard for horizontal split casing pumps.

b) Lubrication fittings and seal piping.

c) Test and /or air vent cocks.

Following fittings shall be provided with each pump among other standard fittings required:

a) Suction and discharge shut off valves (butterfly type) and discharge check valves as specified under section “piping”.

b) Pressure gauge of Glycerin filled and discharges of size not less than 150 mm dia and of the appropriate rating with gauge valves etc.

c) 25mm GI gland drain.

4.0 CONTROL PANEL:

4.1 Cubical Panel:

The main switch board cubicle panel shall be of floor mounted type, totally enclosed, dust and vermin proof made from **14** SWG M.S. sheet of suitable size duly painted with one coat of anti-corrosive paint and two coats of synthetic enamel paint of approved make and shade with stove enameled finish. The cubical shall comprise of the followings:

a) Incoming main M.C.C.B unit of required capacity.

b) Outgoing M.C.C.Bs one for each motor.

c) Aluminium busbar of suitable capacity.

d) Fully Automatic “DOL” starter suitable for the motor H.P. with Push Buttons and ON/OFF indicating light one for each motor. Jockey pump to have DOL starter.

e) Single phasing preventors not required.

f) 96 mm^2 panel type Ampere meters - one for each motor complete with CTs.

g) 150 mm^2 voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.

h) Three neon phase indicating lamps.

i) Rotary switch for manual/auto operation.

j) All colour coded internal and inter-connecting wiring from incoming main to busbar, switch board panel and power/control cables from switch board cubicle to motors, engine and batteries etc. complete in all respect.

All switchgears and accessories shall be approved make to relevant IS codes and to the satisfaction of Client's Representative/Consultant and rating of all equipment must match the KW of motors included and as per rules. All electrical work to be carried out as per BIS standards.

4.2 Earthing:

4.2.1 There shall be two independent earthing stations atleast 3 metres away from the pump room. Each earth electrode shall consists of copper earth plate 600mmx600mmx3mm thick including accessories and masonry enclosure with cover plate having locking arrangement. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connection of 25mmx5mm copper strip. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be rivetted and sheathed. The main earthing strip shall be 25x25mm copper in 40mm dia G.I. pipe from earth electrode as required.

4.2.2 Earth plates shall be buried in a pit 1.2 x 1.2m at minimum depth of 3 metres below ground. The connections between main bar shall be made by means of these 10 mm studs and fixed at 100mm centres. The pit shall be filled with coke breeze, rock salt and loose soil. A G. I pipe of 29mm dia with performations on the periphery shall be placed vertically over the plates to reach ground level or watering.

4.2.3 A brick masonry man hole 30x30x30cms size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated in this manhole for testing.

4.2.4 Earthing shall be done complete as per BIS Standards.

4.3 Cabling:

4.3.1 All cables from switch board panel to the motors shall be XLPE insulated and PVC FRLS sheathed armoured aluminium conductor power cables of 650/1100 V grade conforming to IS:1553. The cables of required size shall be suitable for laying on surface of wall or in flooring with suitable clamps. Necessary cable trays shall deemed to be included in this item as per site requirements.

4.3.2 The termination shall be with brass compression glands suitable for PVC sheathed armoured aluminium conductor cable of 1.1 KV `A' grade of the required size.

5.0 INSTALLATION:

Pump shall be installed as per manufacturer's recommendations. Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. Concrete floating foundation shall be provided by the Owner as per approved shop drawings and specifications. The isolation pads, foundation bolts etc. shall be supplied by the Contractor. Contractor shall however ensure that the foundation bolts are correctly embedded.

Pump sets shall preferably be factory aligned, whenever necessary, site alignment shall be done by competent persons. Before the foundation bolts are grouted and the couplings are bolted, the bed plate levels and alignment results shall be submitted to the Client's Representative.

6.0 TESTING:

Tenderers shall submit the performance curves of the pumps supplied by them. They shall also check the capacity and total head requirements of each pump to match his own piping and equipment layout.

On completion of the entire installation, pumps shall be tested, wherever possible, for their discharge, head, flow rate, B.H.P.

Discharge, head and B.H.P. (as measured on the input side) shall be field tested. Test results shall correspond to the performance.

7.0 MEASUREMENT:

7.1 Pumping sets, and switch board cubicle shall be measured by number and shall include all item necessary and required and given in the specifications.

7.2 Earthing and power/control cabling shall not be measured separately but included in switchgear cubicle and shall include all items necessary and required to complete the work as per specification and relevant IS to the satisfaction of Client's Representative.

7.3 Pressure switches and pressure gauges shall not be measured separately, but included in respective pumping sets and shall include all items necessary and required to complete the work to the satisfaction of Client's Representative.

END SECTION – 2
FIRE PUMPS AND ACCESSORIES

SECTION – 3 FIRE HYDRANT SYSTEM:

1.0 SCOPE:

1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install wet riser fire hydrant system as required by the drawings and specified hereinafter or given in this Bill of Quantities.

Without restricting to the generality of the foregoing, the fire hydrant system shall include the following:

a) Black mild steel (heavy class) mains including valves, hydrants and appurtenances.

b) Black steel pipe fire risers within the building.

c) Landing valves of 63mm diameter canvas hose pipes, hose reels, hose cabinets 63mm diameter fire brigade connections, connections to pumps, appliances and pressure reducing devices, 20mm diameter gunmetal nozzle for hose reel.

d) Excavation, anchor blocks and valve chamber.

e) Underground pipe protection.

f) Underground storage tanks of 100 m^3 each 2 Nos. only connections to these tanks.

2.0 GENERAL REQUIREMENTS:

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Client's Representative.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

3.0 INTERNAL FIRE HYDRANT SYSTEM:

3.1 Scope:

Work under Internal Fire Hydrant System shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install wet riser, fire hydrant system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

Without restricting to the generally of the foregoing Internal fire hydrant system shall include the following:

a) Black mild steel (heavy class) mains including valves, hydrants and appurtenances.

b) Black mild steel fire risers within the building.

c) Landing valves, canvas hose pipes, hose reels, hose cabinets, connections to pumps.

3.2 Pipes and Fittings:

a) All pipes within the building in exposed locations and shafts including connections burried under floor shall be black steel tubes conforming to IS:1239-1979 (heavy class) with screwed flanged or welded joints as specified by the Client's Representative.

b) Pipes (exposed) shall be given one primary coat of red oxide paint and two or more coats of synthetic enamel paint to give an even look (fire red, shade No. 536 as per IS:5).

c) Fittings for M.S. pipes shall be approved type malleable iron (forged fittings) for tapered screwed joints. Fittings shall be approved type steel fittings conforming to IS: 1239-1982 Part - II for screwed joints and welded.

d) All fittings such as bends, tees, etc. for 50mm and below shall be standard forged fittings. Cast iron fittings and fabricated fittings shall not be accepted.

e) Fabricated fitting shall be allowed only when factory certificate shall be produced along with fitting.

f) All piping laid shall be as follows:

Pipe Size	Material	Joints & Fittings	Sealing Material
Up to 50mm	E.R.W., M.S. Pipe	Screwed Fittings	Non-Hardening
	Heavy Class	Unions	Lubricant
	IS:1239/1979	Raised face Slip-on Flanges	3mm, 3-ply Rubber insertion
65mm to 150mm	E.R.W., M.S. Pipe	Welded Fittings	-----
	Heavy Class	Raised face Slip-on Flanges	-----
	IS:1239/1979	-----	3mm, 3-ply Rubber insertion
200mm to 300mm	E.R.W. Welded Pipes	Welded	-----
	Heavy Class	Raised face Slip-on Flanges	3mm, 3-ply Rubber insertion
	IS:3589/1981	------	-----
350mm and Over	E.R.W. Welded Pipes	Welded	-----
	IS:3589/1981	Raised face Slip-on Flanges ------	3mm, 3-ply Rubber insertion -----

f) Pipes shall be provided with electrical resistance welding. Jointing shall be butt welded between pipe and pipe and fittings.

g) Joints between C.I. and M.S. pipes shall be made by provided a suitable flanged tail or sockets piece and M.S. flanges on the M.S. pipe shall have appropriate number of holes and shall be fastened with nuts, bolts and 1.5mm thick compressed asbestos gaskets.

h) Tee off connections shall be through reducing tees. Drilling and tapping of the main walls of the main pipe shall not be allowed.

i) All equipment and valve connections shall be through flanges (Welded or screwed for mild steel).

j) All welded piping is subjected to the approval of the Client's Representative and sufficient number of flanges and unions shall be provided.

k) All welding to be done by qualified X-Ray Welder. 10% Joint shall be X-Ray tested and cost of these activities shall be included in the cost of piping, no extra cost for above mentioned activities shall be paid to the contractor.

3.3 Piping Installation:

Tender drawings indicate schematically the size and location of pipes. The Contractor on the award of the work, shall prepare detailed working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain valves and all pipe support, structural supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass. Drawings to be got approved from Local Fire Authorities.

Contractor shall submit the Hydraulic calculation for the system in accordance with Fire Authority by Laws.

Piping shall be properly supported on or suspended from stand clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated back. Where pipe and clamps are of dissimilar materials a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following:

Pipe Size	Spacing between Supports
3 to 12 mm	1.22 meter
19 to 25 mm	1.83 meter
32 to 150 mm	2.44 meter
150 mm & over	3.05 meter

Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars steel structural supports attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the roof floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point. The Contractor shall coordinate with structural.

Pipe sleeves, 50 mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and annular space filled with fire proof materials like putty, fire seal etc.

Piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation and coordination with other agencies work so that particular area work shall be carried out in one stretch.

Piping layout shall take due care for expansion and contraction in pipes.

All pipes using screwed fittings shall be accurately cut to the required sizes and thread in accordance with IS: 554 and burrs removed before laying. Wherever reducers are to be made, eccentric reducers shall be used.

Air valves shall be provided at all high points in the piping system for venting. Valves shall be of the double float type, with G.M./C.I. body, vulcanite balls, rubber seating etc. Air valves shall be the sizes specified and shall be associated with an equal sizes specified and shall be associated with an equal size gate valve with rising spindle.

Discharge from the air valves shall be piped through an equal sized M.S. pipe to the nearest drain or floor waste or as shown.

Drain shall be provided at all low points in the piping system and shall be of the following sizes:

Mains	Drains
Upto 300mm dia	25mm dia
Over 300mm dia	38mm dia

3.4 Vibration Elimination:

Piping installation shall be carried out with vibration elimination fittings wherever required.

3.5 Valves:

Gate Valves:

Gate valves shall be provided as required or as shown in the applicable shop drawings conforming to the following specifications:

Pipe Size	Material	Joints & Fittings	Sealing Material
	Seat - The Resilient lining moulded black nitile rubber.		
	Disc - SG iron to IS:1865 SG 400/12 and bs:2789 Gr 420/12 Nylon coated.		

Gate valves shall conform to IS:780/1969, Flanges to IS:1536 or as required. Valves shall have non-rising spindles unless otherwise specified and shall be suitable for 21 Kg/Sq.cm test pressure.

Sluice valves of sizes 80mm and above shall be cast iron double flanged solid wedge, outside screw, non rising stem, yoke type bonnet and two piece gland construction. The valves shall have renewable screwed body seat rings. Flanges shall have raised faces and serrated face finish and shall conform to IS:780-1984.

Check valves:

Check valves shall be provided as required or as shown on the drawings and conform to the following specifications:

Size	***Connection***	***Ends***
12mm to 50mm	Gunmetal	Screwed Female
50mm to Over	Gunmetal/C.I.	Flanged

Swing check valves shall normally be used in all water services. Lift type valves may be used in

horizontal runs. Air release and clean out plugs shall be provided whenever required Valves shall be suitable for 21 Kg/Sq.cm test pressure.

Butterfly Valves:

All the isolation valve 50cm and above on the equipment and water lines, where specified or shown on drawings shall be wafer type butterfly valves. They shall be designed to fit without gaskets, the water tight seal being obtained by EPDM seat projection at the faces compressed between the flanges. The valves shall be supplied inclusive of M.S. pipe flanges and high tensile steel bolts of dimensions recommended by suppliers of valves. The valves shall comply with following specifications:

a) Type : body 24 Bar, Seat 16 Bar

b) Valve Component : Material of Construction

i) Body : Cast Iron, Gr. FG 260, IS:210

ii) Disc : Nylon or Epoxy powder coated high duty iron, Gr, FG 260

iii) Stem : Stainless Steel or carbon steel – IS:1570, Part-II.

iv) Seat : Nitrile

v) Hand Lever : Cast Iron (Mechanical Memory Stop)

vi) Bearings : PTFE or Nylon covered S.S. bush bearings at stem and pivot.

vii) Primary Seal : Reinforced PTEE slide bearings

viii) Temperature : 80 Degree C (max.)

Installation:

- Valve shall be install in a manner that allows future removal and service of the valve.
- Packing and gasket shall not contain asbestos.
- The valve shall be of the same size as the pipe to which they are install.
- Valve above 150mm diameter shall be self locking warm gear type water proof and protory lubricated.
- Provide chain operators w/chain cleats on all valves more than 2.4 meter above floor.

3.6 Pressure Gauges:

Pressure gauge shall be of Glycerin filled and not less than 150mm dia dial and of appropriate range and be complete with shut off gauge valve etc. duly calibrated before installation.

Pressure gauge shall be provided at the following locations and as indicated on the drawings and Bill of Quantities. Care shall be taken to protect pressure gauges during pressure testing.

3.7 Internal Hydrants:

Contractor shall provide on each landing and other locations as shown on the drawings one single headed gunmetal landing valve with 63mm dia, outlets and 80mm inlet (IS:5290-1983) with individual shut off valves and cast iron wheels. Landing valves shall have flanged inlet and instantaneous type outlet as shown on the drawings.

Instantaneous outlets for fire hydrants shall be standard pattern approved and suitable for fire brigade hoses.

Contractor shall provide for each internal fire hydrant station two numbers of 63mm dia, 15 metre long rubberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine wound with CI wire (Hose to IS:636 type 2 and couplings to IS:903 with IS certification), fire hose reel, gunmetal branch pipe with nozzle IS:903 and fireman's axe.

Each hose box shall be conspicuously painted with the letters "FIRE HOSE".

3.8 Fire Hose Reels:

Contractor shall provide standard fire hose reels with 20mm dia, high pressure rubber hose of 36 metres length with gunmetal nozzle with 5mm bore, and control valve, connected wall mounted on circular hose reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall conform to IS:884-1969. The hose reel shall be connected directly to the pipe riser through an independent connection.

3.9 Orifice Flanges:

Provide orifice flanges fabricated from 6mm thick stainless steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 Kg/sqmt. The design of the orifice flanges shall be given by the Contractor as per the location and pressure conditions of each hydrants/hose reel and get approved from Client's Representative before installation.

3.10 Fire Hose Cabinets:

Provide hose cabinets for internal hydrants fabricated from 16 gauge MS sheet with single or double glass front door and locking arrangement with breakable glass key access arrangement, duly painted red with stove enameled paint fixed to wall or self supported on floor as per site conditions. The cabinet shall also have a separate chamber to keep the key with breakable glass as per approved design. Hose cabinets shall be stove enameled fire red paint with "FIRE HOSE" written on it prominently. Samples of hose cabinet for internal and external works are got approved from Client's Representative before installation at site.

Fire hose cabinet suitable to accommodate 2 Nos. landing valves, 2 Nos. 15 metres long hoses, 1 no. First aid reel, 2 Nos. branch pipe and 2 Nos. fire extinguishers or as given in BOQ.

3.11 Drain Valve:

Provide 50mm dia, MS pipe to IS:1239 (heavy class) with 50mm gunmetal full way valve for draining any water in the system in low pockets same to be extended to the nearest drain point as directed by Client's Representative.

3.12 Air Valves:

Provide 25mm dia, screwed inlet spring type single acting brass air valve on all high points in the system or as shown on drawings on top of air cushion tanks.

3.13 Flow Meter:

Provide “Venturi Type” flow meter on each pump test. The flow aliment shall be as venturi tube, fiberglass reinforced polyester plastic body with stainless steel connections.

The flow indicator shall be well type mercury manometer suitable for closed valve pressure of the pump.

Provide over scale fluid check valve, three way manifold, vent plugs, shut off valves, and all other necessary trimings.

Allow for at least five (5) diameters of straight pipe upstream and down stream of the venturi tube flanges.

The flow meter indicator shall be positioned in a suitable location to enable easy reading and in any case shall not be installed more than 1.8 metre above finished floor level.

The flow meter shall be factory mutual approved.

3.14 Testing:

All piping shall be tested to hydrostatic test pressure of 15 Kg/Sq.cm or twice the design pressure whichever is higher for a period of not less than 2 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Client’s Representative.

Piping required subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped.

The Client’s Representative shall be notified well in advance by the Contractor of his intention to test a section of piping and all testing shall be witnessed by the Client’s Representative.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the system concerned. If proper circulation is not achieved due to air bound connections, the Contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification including the tarring-up and re-finishing of floors, walls etc. as required.

The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test, and shall ensure that the plant room and other areas are cleaned up and spill over water is removed.

The Contractor shall give the pressure test of head for external yard hydrant at ground level and also for hydrant at terrace level.

3.15 Painting:

All pipes in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade after the Hydrostatic test pressure of the internal hydrant piping network.

3.16 Measurement:

Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings, welding, jointing, clamps for fixing to walls or hangers, anchor fasteners and testing.

Sluice valves with orifice flanges, check valves and full way valves shall be measured by numbers and shall include all items necessary and required for mixing and as given in the Specifications/Bill of Quantities.

Landing valves, hose cabinets, rubberized fabric linen fire hose pipes. First-aid fir hose reels (with gunmetal port way valves) and gunmetal branch pipes shall be measured by numbers and shall include all items necessary and required for fixing as given in the Specifications/Bill of Quantities.

Suction and delivery headers shall be measured per linear meter of finished length and shall include all items as given in the Bill of Quantities. Painting shall be included in the rate of headers.

Painting of pipes shall be included in the rate for pipes and no separate payment shall be made.

No additional payment shall be admissible for cutting holes or chases in walls or floors, making connections to pumps, equipment and appliances.

4.0 EXTERNAL FIRE HYDRANT SYSTEM:

4.1 Scope:

Work under external fire hydrant system shall consist of furnishing labour, materials, appliances necessary and required to completely install external fire hydrant system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

Without restricting to the generally of the foregoing the external fire hydrant system shall include the following:

a) Black mild steel (heavy class) mains including valves, yard hydrants.

b) Landing valves, canvass hose pipes, hose cabinets, fire brigade connections.

c) Excavation, anchor block and valve chamber.

d) Under ground pipe protection.

4.2 Pipes and Fittings:

a) All pipes within the building in exposed locations and shafts including connections burried under floor shall be black steel tubes conforming to IS:1239-1979 (heavy class) with screwed flanged or welded joints as specified by the Client's Representative.

b) Pipes (exposed) shall be given one primary coat of red oxide paint and two or more coats of synthetic enamel paint to give an even look (fire red, shade No. 536 as per IS:5).

c) Fittings for M.S. pipes shall be approved type malleable iron (forged fittings) for tapered screwed joints. Fittings shall be approved type steel fittings conforming to IS:1239-1982 Part - II for screwed joints, welded.

d) All fittings such as bends, tees, etc. for 50mm and below shall be standard forged fittings. Cast iron fittings and fabricated fittings shall not be accepted.

e) All piping laid shall be as follows:

Pipe Size	Material	Joints & Fittings	Sealing Material
Up to 50mm	E.R.W., M.S. Pipe	Screwed Fittings	Non-Hardening
	Heavy Class	Unions	Lubricant
	IS:1239/1979	Raised face Slip-on Flanges	3mm, 3-ply Rubber insertion
65mm to 150mm	E.R.W., M.S. Pipe	Welded Fittings	-----
	Heavy Class	Raised face Slip-on Flanges	-----
	IS:1239/1979	-----	3mm, 3-ply Rubber insertion
200mm to 300mm	E.R.W. Welded Pipes	Welded	-----
	Heavy Class	Raised face Slip-on Flanges	3mm, 3-ply Rubber insertion
	IS:3589/1981	------	-----
350mm and Over	E.R.W. Welded Pipes	Welded	-----
	IS:3589/1981	Raised face Slip-on Flanges	3mm, 3-ply Rubber insertion
		------	-----

f) Pipes shall be provided with electrical resistance welding. Jointing shall be butt welded between pipe and pipe and fittings.

g) Joints between C.I. and M.S. pipes shall be made by provided a suitable flanged tail or sockets piece and M.S. flanges on the M.S. pipe shall have appropriate number of holes and shall be fastened with nuts, bolts and 1.5mm thick compressed asbestos gaskets.

h) Tee off connections shall be through reducing tees. Drilling and tapping of the main walls of the main pipe shall not be allowed.

i) All equipment and valve connections shall be through flanges (Welded or screwed for mild steel).

j) All welded piping is subjected to the approval of the Client's Representative and sufficient number of flanges and unions shall be provided.

4.3 Piping Installation:

Tender drawing indicates schematically the size and location of pipes. The Contractor on the award of the work shall prepare detailed working drawings showing the cross-section longitudinal sections, details of fittings, locations of isolating and drain valves and all pipe support. Drawings to be got approved from Local Fire Authorities.

Contractor shall submit the Hydraulic calculation for the system in accordance with Fire Authority By Laws.

Piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, building, roads and structure. The entire piping work shall be organized in consultation and coordination with other agencies work so that particular area work shall be carried out in one stretch.

Piping layout shall take due care for expansion and construction in pipes.

All buried pipes shall be cleaned and treated by applying one coat of PYPKOTE primer and shall be covered with 4mm thick PYPKOTE anticorrosive tape after the hydrostatic test pressure of the piping network. The treated pipe is required to be tested with spark / holiday test at site before burying at no extra cost.

4.3.1 Cost Iron Class (LA) Pipes:

Cast iron class (LA) pipe shall be such that it could be cut, drilled or machined. Centrifugally cast pipe in water cooled moulds shall be heat treated to achieve necessary mechanical properties and to relieve casting stresses; provided that the specified mechanical properties are not.

Material:

Flanged cast iron pipe shall be centrifugally spun cast iron pipe conforming to IS: 1536-1976.

Fittings:

Fittings used for cast iron calls (LA) pipes shall conform to IS: 1538-1976 Junction from branch pipe shall be made by wyes, wherever possible.

All cast Iron water main pipes and fittings shall be manufactured to IS: 1536 and shall be of tested quality. The pipes and fittings shall be flanged type. The pipes and fittings shall be of uniform material throughout and shall be free from manufacturing defects. The flanges shall be at right angles to the axis of pipe and machined on face. The bolt holes shall be drilled. The bolt hole circle shall be concentric with the bore, and the two flanges of the pipe shall be correctly aligned.

Jointing:

Rubber gasket for use on push on joints shall conform to IS:12820-1989. The nuts and bolts used to fasten the flanges shall be High Tensile variety, suitable for 15KG/Cm^2 pressure and shall be galvanized.

4.4 Excavation:

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1 metre or as shown on the drawings.

Wherever, required Contractor shall support all trenches or adjoining structures with adequate timber supports at his own cost.

At joints the trench width shall be widened where necessary. All M.S. pipes below ground in trenches minimum cover over pipes shall be 100cm. Covered shall be measured from top of pipe to the surface of ground. The bed of the trench if in soft or made up earth, shall be well watered and rammed before laying the pipes and depressions if any shall be properly filled with earth and consolidated in 20cm layers.

If the trench bottom is extremely hard and rocky or loose story soil, the trench shall be excavated at least 150mm below the trench grade. Rocks, Stone or other hard substances from the bottom of the trench brought back the required grade by filling with selected fine earth or sand and compacted so as to provide smooth bedding for the pipe. When excavation required blasting operation, it shall

be ensured that no pipes have be stacked in the vicinity and completed pipe in the vicinity has already been covered before starting of blasting operations; this is necessary to prevent damage to the exposed pipe in the vicinity by falling stone as result of blasting.

After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrel of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces lift for jointing the under side of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.

Roots of tree within distance of about 0.5 meter from the side of the pipe line shall be removed or killed.

The excavated materials shall be placed within 1 meter or half of the depth of the trench, whichever is greater, from the edge of the trench. The material excavated shall be separated and stacked so that in refilling they may be re-laid and completed the same order to satisfaction of the Client's Representative.

The filling shall be done in layers not exceeding 15mm in depth. Each layer shall be wasted, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of the crow brass where rammers can not be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches.

Filling in trenches shall be commenced soon after the joints of pipes, cables; conduits etc. have been tested and approved by Client's Representative. The space around the pipes shall be cleared of all debris where the trenches are excavated in hard/soft soil. The filling shall be done with earth on the sides and tops of pipes in layers not exceeding 15mm in depth. Each layer shall be watered rammed and consolidated. The clods and lumps of earth exceeding 8cm in any direction shall be broken or removed before the excavated earth is used for filling. Generally no test is done to determine the instu diversity of filled earth but on the discretion of Client's Representative the 95 proctor's compaction test may be done to ensure the in situ density after filling. Consolidation is removal of water from the pores and compaction is the explosion of air from the pores. In case of refilling consolidation places most important role as the watering of the each layer is being done properly. If required by the Client's Representative proctors needle may also be used for the proper checking of the refilling items of in situ density.

4.5 Anchor Blocks:

Contractor shall provide suitable cement concrete anchor blocks of ample dimensions at all bends, tee connections and other places required and necessary for overcoming pressure thrusts in pipes. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal gauge).

4.6 Valves:

Gate Valves:

Gate valves shall be provided as required or as shown in the applicable shop drawings conforming to the following specifications:

Pipe Size	Material	Joints & Fittings	Sealing Material
	Seat - The Resilient lining moulded black nitile rubber.		
	Disc - SG iron to IS:1865 SG 400/12 and bs:2789 Gr 420/12 Nylon coated.		

Gate valves shall conform to IS:780/1969, Flanges to IS: 1536 or as required. Valves shall have non-rising spindles unless otherwise specified and shall be suitable for 21 Kg/Sq.cm test pressure.

Sluice valves of sizes 80mm and above shall be cast iron double flanged solid wedge, outside screw, non rising stem, yoke type bonnet and two piece gland construction. The valves shall have renewable screwed body seat rings. Flanges shall have raised faces and serrated face finish and shall conform to IS:780-1984.

Check valves:

Check valves shall be provided as required or as shown on the drawings and conform to the following specifications:

Size	***Connection***	***Ends***
12mm to 50mm	Gunmetal	Screwed Female
65mm to Over	Gunmetal/C.I.	Flanged

Swing check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Air release and clean out plugs shall be provided whenever required Valves shall be suitable for 21 Kg/Sq.cm test pressure.

Butterfly Valves:
All the isolation valve 50cm and above on the equipment and water lines, where specified or shown on drawings shall be wafer type butterfly valves. They shall be designed to fit without gaskets, the water tight seal being obtained by EPDM seat projection at the faces compressed between the flanges. The valves shall be supplied inclusive of M.S. pipe flanges and high tensile steel bolts of dimensions recommended by suppliers of valves. The valves shall comply with following specifications:

a) Type : Body 24 Bar Seat 16 Bar

b) Valve Component : Material of Construction

i) Body : Cast Iron, Gr. FG 260, IS:210

ii) Disc : Nylon or Epoxy powder coated high duty iron, Gr, FG 260

iii) Stem : Stainless Steel or carbon steel – IS:1570, Part-II.

iv) Seat : Nitrile

v) Hand Lever (Mechanical Memory Stop) : Cast Iron

vi) Bearings : PTFE or Nylon covered S.S. bush bearings at stem and pivot.

vii) Primary Seal : Reinforced PTEE slide bearings

viii) Temperature : 80 Degree C (max.)

Installation:

- Valve shall be install in a manner that allows future removal and service of the valve.
- Packing and gasket shall not contain asbestos.

- The valve shall be of the same size as the pipe to which they are install.
- Valve above 150mm diameter shall be self locking warm gear type water proof and protory lubricated.
- Provide chain operators w/chain cleats on all valves more than 2.4 meter above floor.

4.7 External Hydrant:

External Hydrants (Yard Hydrants) shall confirm to and marked IS:5290 (type `A'). Along side of each hydrant, there shall be a hose box to accommodate two numbers of C.P. hoses each of 63mm dia and 15M long confirming to IS:8423 complete with instantaneous ISI marked Gun-metal Male and Female couplings (IS:903) and 1 no. 63mm dia ISI marked Gun-metal Short Branch Pipe with nozzle (IS:903) complete with wall anchors, chain attached moveable caps and polish brass trim.

4.8 Fire Brigade Connections:

The Contractor shall provide gun-metal Fire Brigade collecting head with four Nos. 63mm dia instantaneous type inlets with built in check valves and 150mm dia flanged outlet connection. The collecting heads shall be connected to underground Fire water tank and fire water main header for the use of local Fire Brigade.

4.9 Valve Chamber:

Contractor shall provide suitable brick masonry chamber of size as indicated in Bill of Quantities in cement mortar 1:5 (1 cement:5 coarse sand) on cement concrete foundations 150mm thick 1:5:10 mix (1 cement: 5 fine sand :10 graded stone aggregate 40mm nominal size) 15mm thick cement plaster inside and outside finished with a floating coat of neat cement with Cast Iron surface box or ci. Cover approved by Fire Brigade including excavation, back filling complete.

4.10 Drain Valve:

Provide 50mm dia, MS pipe to IS:1239 (heavy class) with 50mm gunmetal full way valve for draining any water in the system in low pockets as directed by Client's Representative.

4.11 Pipe Protection:

All pipes above ground and in exposed locations shall be painted with one or more coat of red-oxide primer and two or more coats of synthetic enamel paint of approved shade after the hydrostatic test pressure of the piping network.

The pipes burried in soil shall be treated by applying one coat of PYPKOTE primer and shall be covered with 4mm thick PYPKOTE anticorrosive tape after the hydrostatic test pressure of the piping network. The treated pipe is required to be tested with spark / Holyday test at site before burying the pipe at no extra cost.

4.12 Testing:

All piping shall be tested to hydrostatic test pressure of 15 Kg/Sq.cm or twice the design pressure whichever is higher for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Client's Representative.

Piping required subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped.

The Client's Representative shall be notified well in advance by the Contractor of his intention to test a section of piping and all testing shall be witnessed by the Client's Representative.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the

system concerned. If proper circulation is not achieved due to air bound connections, the Contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification including the tarring-up and re-finishing of floors, walls etc. as required.

The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test, and shall ensure that the plant room and other areas are cleaned up and spill over water is removed.

The Contractor shall give the pressure test of head for external yard hydrant at ground level and also for hydrant at terrace level.

4.13 Measurement:

Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings (except flanges), welding, jointing, clamps for fixing to walls or hangers, anchor fasteners and testing.

Sluice valves with orifice flanges, check valves and full way valves shall be measured by numbers and shall include all items necessary and required for mixing and as given in the Specifications/Bill of Quantities.

Landing valves, hose cabinets, rubberized fabric linen fire hose pipes. First-aid fir hose reels (with gunmetal port way valves) and gunmetal branch pipes shall be measured by numbers and shall include all items necessary and required for fixing as given in the Specifications/Bill of Quantities.

Suction and delivery headers shall be measured per linear meter of finished length and shall include all items as given in the Bill of Quantities. Painting shall be included in the rate of headers.

Painting of pipes shall be included in the rate for pipes and no separate payment shall be made.

No additional payment shall be admissible for cutting holes or chases in walls or floors, making connections to pumps, equipment and appliances.

END SECTION – 3
FIRE HYDRANT SYSTEM

SECTION – 4 SPRINKLER SYSTEM (INTERNAL ONLY):

1.0 SCOPE:

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install the sprinkler system as required by the drawings and specified hereinafter or given in this Bill of Quantities.

a) Sprinkler mains, branch and connection from external piping complete with valves, alarm, hangers, appurtenances and painting.

b) Sprinkler heads with spare sprinklers.

c) Connections to risers, pumps and appliances.

d) Flow switches, installation valve

e) Vertical drain pipes.

2.0 GENERAL REQUIREMENTS:

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Client's Representative.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

Fabricated fitting shall be allowed only when factory certificate shall be produced along with fitting.

3.0 PIPES AND FITTINGS:

Pipes for sprinkler system network shall be mild steel (black) confirming to IS: 1239 (heavy class) with screwed/welded joints having flanges at regular intervals not exceeding 24 M.

Fittings for steel pipes shall be of heavy class forged steel having tapered pipe threads. For pipe sizes 50mm and above, fabricated fitting shall not be accepted.

4.0 JOINTING:

Joints for mild steel pipes and fittings shall preferably be metal to metal tapered thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. Joints for 50mm dia and above, however, may be of butt-welded type using heavy class butt welded fittings. However, sprinkler heads shall be screwed with Teflon or equal bonding tape.

Joints between CI or black steel pipes and valves and other appurtenances, pumps etc. shall be made with CI or MS flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick compressed synthetic rubber insertion gaskets. All flanges shall confirm to IS: 6392-1971 Table 17/18 with regards to material, thickness as well as dimensions.

5.0 PIPE SUPPORTS:

All pipes shall be adequately supported at a maximum interval of 3 M from roofs or walls from existing inserts if available, by structural clamps fabricated from MS structural e.g. rods, channels, angles and flats to the prior approval of Consultant. All clamps shall be painted with one coat of red lead and two coats of black enamel paint of approval quality. Where existing inserts not available, the Contractor shall provide anchor fasteners. Table as given in clause 3.3 of section 3.

Pipes shall be measured by linear metre and shall include all fittings, flanges, jointing, clamps, hangers, and all other material necessary and required whether specified or not to complete the system including painting, testing and commissioning.

6.0 PIPE PROTECTION:

All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.

7.0 VALVES:

7.1 Sluice Valves and Non Return Valves:

Sluice valves of sizes 80mm and above shall be cast iron double flanged with non rising spindle and gunmetal inner. Sluice valve below ground shall be provided with caps suitable for operations by a key. Sluice valves in exposed location e.g. pump house, etc. shall be provided with cast iron wheels. Sluice valve shall conform to IS: 780 Class-I.

Check valves shall be cast iron double flanged conforming to IS: 5312-1984 with cast iron steel body 13% chrome steel disc, hinge pin and body seat ring.

Valves on MS pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel conforming to IS: 778-1984 (Class-II).

7.2 Butterfly Valve:

All the isolation valve 50cm and above on the equipment and water lines, where specified or shown on drawings shall be wafer type butterfly valves. They shall be designed to fit without gaskets, the water tight seal being obtained by **Nitrile** seat projection at the faces compressed between the flanges. The valves shall be supplied inclusive of M.S. pipe flanges and high tensile steel bolts of dimensions recommended by suppliers of valves. The valves shall comply with following specifications:

a)	Type	: Body 24 Bar Seat 16 Bar
b)	Valve Component	: Material of Construction
i)	Body	: Cast Iron, Gr. FG 260, IS:210
ii)	Disc	: Nylon or Epoxy powder coated high duty iron, Gr, FG 260
iii)	Stem	: Stainless Steel or carbon steel – IS:1570, Part-II.
iv)	Seat	: Nitrile
v)	Hand Lever (Mechanical Memory Stop)	: Cast Iron

vi) Bearings : PTFE or Nylon covered S.S. bush bearings at stem and pivot.

vii) Primary Seal : Reinforced PTEE slide bearings

viii) Temperature : 80 Degree C (max.)

Installation:

- Valve shall be install in a manner that allows future removal and service of the valve.
- Packing and gasket shall not contain asbestos.
- The valve shall be of the same size as the pipe to which they are install.
- Valve above 150mm diameter shall be self locking warm gear type water proof and protory lubricated.
- Provide chain operators w/chain cleats on all valves more than 2.4 meter above floor.

7.3 Drain Valve:

Provide 50mm diameter MS pipe to IS:1239 (heavy class) with 50mm gunmetal full way valve for draining any water in the system in low packets same to be extended to nearest drain point as directed by Client's Representative.

7.4 Air Valve:

Provide 25mm diameter screwed inlet spring type single acting brass air valve on all high points in the system.

8.0 GLOBE VALVES FOR TESTING & DRAINING:

The Contractor shall provide 15mm dia Gun-metal globe valve with GI pipe as per IS:1239 heavy class for testing and draining any water in the system in low pockets wherever required. This item shall be measured by numbers and shall include 15mm dia, globe valve, 15mm dia GI pipe (max. 6 M length), fittings, tees, elbows, unions, supports, hangers and all other items necessary and required to complete the work.

9.0 AIR VESSEL/AIR CUSHION TANK:

Air vessel (air cushion tank) shall be of size and capacity indicated in Bill of Quantities. It shall be provided at the top most point/points or in pump house (as specified). The tank shall be complete with 20mm dia brass air valve (Ball type), stop valve (20mm dia), drain valve (20mm dia) and pressure gauge including 20mm dia mild steel galvanised pipes and fittings, unions, etc. as required to complete the work as per site conditions.

Air Cushions tank shall be measured by numbers and shall include air valve, pressure gauge, globe valves for testing and draining, M.S. clamps, pipes, fittings, tees, elbows, union and all other items required to complete the work.

10.0 FLOW SWITCH:

Provide one electrically operated flow indicating switch of appropriate diameter at the head of each circuit. Flow switches should be capable of the required flow in the circuit. The electrical cabling for the flow switches and control panel shall be provided by the Contractor.

11.0 SUPERVISORY SWITCH:

Provide a supervisory switch attached to each supervised valve. The supervisory switch shall monitor the valve position and signal valve tempering. The switch shall consist of a single pole, double throw switch with a roller type switch actuator and a spring loaded plunger. The switch shall be U. L. listed and F. M. approved.

12.0 SPRINKLER HEADS:

Sprinkler heads shall be provided at regular spacing so as to cover 9 Sq.metre per sprinkler head. The spacing shall however be in conformity with the drawings and properly coordinated with electrical fixtures, ventilation ducts and grills and other services along the ceiling. Sprinkler head shall be of brass quartz bulb type with a temperature rating of 68 Deg. C. Sprinkler heads shall be of pendent type.

Alternatively sprinklers may be of side wall type with fusible link for operation.

Sprinkler heads shall be approved by the Underwriters Laboratories (U.L.) or Fire Officers Committee (FOC), Tarrif Advisory Committee (TAC). The finish shall be as specified in Bill of Quantities.

Contractor shall install cabinet fabricated from 16 gauge MS sheet with lockable glass shutters. Shelves for keeping spare sprinklers and spanner at locations approved by the Client's Representative and given in the Bill of Quantities.

13.0 INSTALLATION CONTROL VALVE:

Installation control valve for sprinkler system shall consist of a vertical alarm valve complete with 50mm dia drain and 15mm test valve with a provision to install water operated turbine alarm. A cast iron sluice valves shall be provided on upstream of alarm valve. The size of alarm valve and sluice valve shall be as indicated in BOQ.

One water operated turbine alarm motor with gong to be provided for each sprinkler installation control valve on the sprinkler main. The alarm shall operate and sound a gong on the drop of pressure and flow of water in the mains. Turbine alarm shall be approved by the Client's Representative and installed at approved locations. The alarm shall be provided with suitable test cock. Both alarm valve and turbine alarm must have TAC/FOC/UL/FM approval/listing.

Installation control valve shall be measured by numbers and shall include upstream C.I. sluice valve, alarm valve, alarm motor and gong, drain valve, test valve, drain piping (50mm dia G.I. upto 5 M) and all fittings including 2 Nos. pressure gauges required to complete the work.

14.0 TESTING:

All piping in the system shall be tested in the presence of Consultant/ Client's Representative to a hydrostatic pressure of 14 Kg./Sq.cm or twice the design pressure (whichever is higher) without any drop in pressure for at least 2 hours and thereafter the entire system shall be hydraulically tested at 3.5 Kg/Sq.cm above the pump shutoff pressure or 12 Kg/Sq.cm (whichever is higher) for 24 hours without any drop in pressure.

Contractor shall rectify leakage, if any and replace all defective components and retest the system as per above requirements to the satisfaction of and Consultant/Client's Representative.

If required by Client's Representative, at least 10% of all the welded joints shall be radio-graphically tested by the Contractor and half the joints radio-graphed shall be field joints. It will be Contractors responsibility to arrange radiography.

Contractor shall give the water flow test of pumps as required by the Client's Representative.

15.0 ANNUNCIATION PANEL:

15.1 Annunciation panel in general shall confirm to IS:2189. The equipment for the main board shall be compact, neatly wired and completely of solid state design. The panel shall be of wall and /or floor mounting type, totally enclosed dust and vermin proof type made of 16 SWG dust inhibited MS sheet of suitable size and having lockable glass front suitable to accommodate accessories as specified, with oven backed finish duly painted with one coat of anti-corrosive paint and two coats of synthetic enamel paint. The primary function of control panel shall be to respond automatically to the operation of one or more detectors to give fire alarm and to indicate area (zone) where the device(s) are activated. The operation of one or more sprinklers shall result in simultaneous alarm by the following:

a) The external alarm hooters at floor of actuation.
b) A visible indication on control panel.
c) Audible alarm on control panel itself (common to all zones).

15.2 The secondary function on the control panel shall be to indicate the faults within the system. An immediate fault warning shall be given by an audible and visual signal on the control panel. A fault warning shall be given in case of the following occurrences:

a) Failure or disconnection of normal power supply.

b) Short-circuit or disconnection of the leads to trigger devices unless the fault condition reproduce the effect of the operation of a triggered device.

c) Removal of any triggered device of the plug-in type or disconnection from its transmitter or power supply.

d) Short-circuit or disconnection of any of the leads to alarm sounders external to the control and indicating equipment.

In addition to above, visual warning shall be given on the Control panel for failure or disconnection of standby power supply and rapture or disconnection of any fuse on the operation of any protective devices that would prevent a fire alarm being given. The healthiness of battery charging equipment shall be indicated by a charging meter and an LED.

15.3 A facility shall also be provided for sending fault signal to remote centres, if required.

15.4 There shall be one indicator for fire and one for fault in the control panel corresponding to each zone. Each zone shall have two bulbs of fire/fault indication. Each indicator shall be clearly labeled with zone no. and inscribed with the "Code Name" i.e. words "FIRE" or "FAULT" or "SILENCE". Separate indicator must be provided in green for system standby on etc.

15.5 The control panel shall derive 230 V, A.C. power from normal supply and the entire fire alarm and detection system shall be suitable for operation on 24 V.D.C A. A standby power supply shall be immediately available in the event of failure of normal supply and shall automatically be connected as to maintain the equipment in condition such that fire alarm originating from the operation of detector in separate zone can be subsequently given.

15.6 The standby power supply should be capable of maintaining the system in normal operation for a period of not less than 48 hours after the failure of normal mains supply after which sufficient capacity would remain to provide full load operation for at least 30 minutes. The full load would be defined as that caused by the operation of all the alarm sounders operating simultaneously, operation of a detector in at least 25 percent of zones (with a minimum of 2 zones) and the operation of the fault indicator. The operation of trigger devices in further zones should not result in cancellation of fire alarm existing at that time.

15.7 Actuation of any zone/detector/fault shall be indicated automatically on these panels (Audio/visual) clearly indicating the relevant zone and visual indication shall continue to remain ON till the fault is removed.

16.0 MEASUREMENTS:

Black steel pipes shall be measured per linear meter of the finished length and shall include all fittings (except flanges), welding, jointing, clamps for fixing to walls or hangers and testing.

Flanges shall be measured per numbers and shall include 3mm thick insertion rubber gasket, nuts and bolts and testing.

Sluice valves, check valves and full way valve and flow indicating switches shall be measured by numbers and shall include all items necessary and required for fixing as given in specifications.

Cabinet spare sprinkler heads with spanners shall be measured as per actual item given in the Bill of Quantities.

Sprinkler heads shall be measured by numbers.

No additional payment shall be admissible for cutting holes, or chases in the wall or floors, making connections to pumps, equipment and appliances.

END SECTION – 4
SPRINKLER SYSTEM (INTERNAL ONLY)

SECTION – 5 COMMISSIONING OF FIRE FIGHTING SYSTEM:

1.0 SCOPE:

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the Contractor under this contract.

2.0 GENERAL REQUIREMENTS:

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

Contractor shall get the thread test between the Fire Department Hose and service connections.

3.0 PRE-COMMISSIONING:

On completion of the installation of all pumps, piping, valves, pipe connections, electrical wiring, motor control panels and water level controlling devices the Contractor shall proceed as follows:

Testing of M.C.C.:

Tests to be carried out for motor control centres shall be:

i) Insulation resistance test with 500 volt megger, before and after high voltage test, on all power and control wiring.

ii) High voltage test at 3000 Volts A. C. for one minute on all power and control wiring.

iii) Low voltage continuity test (6 volts) on power wiring of each feeder, between bus bars and outgoing terminals with switches and contactors in closed position.

iv) Low voltage continuity test (6 volts) on all control wiring.

v) Operation test for all feeders with only control supply made “ON” to ensure correctness of control wiring, operation of the various equipment used, such as push buttons, protective devices, indicating lamps and relays, etc. All contactors shall be checked for the earth bus provided in the M.C.C.

vi) Operation of all instruments and meters provided on the M.C.C.

4.0 FIRE PROTECTION SYSTEM:

i) Check all hydrant valves and close if any valve is open. Check that all suction and delivery connections are properly made.

ii) Test run and check rotation of each motor and correct the same if required.

5.0 PIPE WORK:

i) Check all clamps, supports and hangers provided for the pipes.

ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications if any leakage is found. Rectify the same and retest the pipes.

6.0 COMMISSIONING AND TESTING:

Fire Hydrant System:

i) Pressurize the fire hydrant system by running the main fire pump and after attaining the required pressure shutoff the pump.

ii) Open bye pass valve and allow the pressure to drop in the system. Check that the jockey pump cuts in and cuts out at the pre-set pressures. If necessary adjust the pressure switch for the jockey pump. Close bye pass valves.

iii) Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump should cut in at the present pressure and should not cut out automatically on reaching the normal line pressure. The main fire pump should stop only by manual push button. However, the jockey pump should cut out as soon as the main pump starts.

iv) Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.

v) When the fire pump have been checked for satisfactory working `ON' automatic controls open fire hydrant valves simultaneously and allow the hose pipes to discharge water in to the fire tank to avoid wastage. The electrically driven pump should run continuously for 8 hours so that its performance can be checked.

vi) Diesel engine driven pump should also be checked in the same manner as given in para above by running for 8 hours.

vii) Check each landing valves, male and female coupling and branch pipes for compatibility with each other. Any fitting which is found to be incompatible and does not fit into the other properly shall be replaced by the Contractor. Landing valves shall also be checked by opening and closing under pressure.

7.0 SPRINKLER SYSTEM:

i) Start the sprinkler pump and develop the right pressure in the sprinkler pipes.

ii) Open the test valve to check the automatic starting of the pump. If necessary make adjustments in the setting of the pressure switch. The sprinkler fire alarm should also operate when the test valve is open.

iii) After satisfactory operation of the pump the Contractor shall set up mock fire and test the system.

8.0 HANDING OVER:

i) All commissioning and testing shall be done by the Contractor to the complete satisfaction of the Client's Representative/consultant, and the job handed over to the client.

ii) Contractor shall also hand over to the client all maintenance and operation manuals and all items as per the terms of the contract.

iii) Contractor shall arrange the inspection from Local Fire Authority to inspect the systems installed by him. Contractor shall arrange to get the system completion and satisfactory working certificate from the local Fire Authority after the inspections conducted by the Local Fire Authority.

END SECTION – 5
COMMISSIONING OF FIRE FIGHTING SYSTEM

SECTION – 6 HAND APPLIANCES:

1.0 SCOPE:

Work under this section shall consist of furnishing all labour, material, appliances and equipment necessary and required to install fire extinguishing hand appliances.

Without restricting to the generality of the foregoing the work shall consist of the following:

Installation of fully charged and tested Fire Extinguishing Hand Appliances as required by these specifications and drawings.

2.0 GENERAL REQUIREMENTS:

2.1 Fire extinguishers shall conform to the following Indian Standard specifications and shall be with BIS approved stamp as revised and Amended upto date.

2.1.1 Water-CO2 Type:

These extinguishers shall conform to IS:940 and shall be provided for areas having A-Class fire hazards from wood, paper, plastic, cloth and rubber.

This shall not be used for electrical fires.

2.1.2 Dry Chemical Power (DCP) Type:

These Extinguishers shall conform to IS:2171 and shall be provided for areas having fire hazards from B and C class fires, specially for running fires involving inflammable liquids like petrol, paints or gas and also on energized electrical equipments.

Use of these Extinguishers may be avoided on precision and costly electrical equipments where other type (CO2 Type) equipments may be used.

2.1.3 CO_2 Type Extinguishers:

These Extinguishers shall conform to IS: 2878 and may be used on any type of electrical fires and on fires involving inflammable liquids and gases.

2.1.4 ABC (Power Type) Extinguisher:

These Extinguishers shall conform to IS: 1349-1993 with ABC Power (mono Ammonium Phosphate) pressured by Nitrogen, effective on all kinds of fire.

2.1.5 Test Demonstration:

At least 1 extinguisher per each type shall be demonstrated at site in simulated fire conditions.

2.2 Fire extinguishers shall be installed as per Indian Standard Code of practice for selection, installation and maintenance of portable first aid appliances IS:2190-1979.

2.3 Hand appliances shall be installed in readily accessible locations with the Appliance brackets fixed to wall by suitable anchor fasteners.

2.4 Each appliances shall be provided with an inspection, testing, change of charge and other relevant data.

2.5 All appliances shall be fixed in a true workman like manner truly vertical and at current locations.

3.0 Measurements:

Fire extinguishers shall be measured by numbers and include installation and all items necessary and required and given in the Bill of Quantities.

END SECTION – 6
HAND APPLIANCES

SECTION – 7 GAS FLOODING SYSTEM

1.0 SCOPE

The scope covers Supply, Installation, Testing and Commissioning of Automatic Clean Agent Flooding System complete for electrical panels with fire trace tube, cylinder, valves, integration with Main Fire Alarm Control Panel for status monitoring etc. The work to be executed by authorized & certified Fire Trace installer shall cover:

i. Providing Direct Panel Gas Flooding System with linear Fire trace tube inside the panels.
ii. Arrangement of Clean Gas Agent for flooding inside the panels.
iii. Audio-visual annunciation devices for indicating incidence of fire.
iv. Any other item required to the successful commissioning of the system.

The electrical panel fire suppression system shall be complete with Direct Clean Gas storage cylinders for required capacities, extinguishing agent as specified, linear fire trace tubing, filling and end-of-line adaptors, pressure switches, control equipment and all necessary accessories and push in fittings to form a complete and working installation to protect the Electrical panel in case of fire.

The panels to be protected shall be determined as per the approval of the engineer-in-charge.

The system will have an interface with Main Fire Alarm and Control Panel. In case of fire in the concerned Panel, indication of Fire Trace discharge status should come in Main Fire Alarm and Control Panel.

2.0 REGULATORY REQUIREMENTS

2.1 All the detecting devices, alarm, indicating devices, containers and other related equipment shall be UL Listed and/or FM approved and/or LPCB approved.

2.2 All installations shall conform to NFPA requirements.

2.3 Clean Agent used should be NOVEC-1230.

3.0 SYSTEM DESCRIPTION

3.1 The Clean Agent Pre-Engineered automatic direct fire suppression system shall be approved by Underwriters Laboratories/Factory Mutual/LPCB.

3.2 Each clean agent pre-engineered automatic system is equipped with its own detection/discharge Fire trace tubing. The pre-engineered concept minimizes the amount of engineering involved in system design. When the detection/Discharge tubing is installed within the limitations stated in the manufacturer manual, no hydraulic calculations are required to determine the pressure drop, agent flow or discharge time.

3.3 Each Clean Agent extinguishing unit, when installed, is a self-contained system, meaning that it is equipped with its own automatic (non-electric) detection system, which when actuated, automatically releases the suppression agent into the Electric panel.

3.4 The Clean Agent Automatic Direct System consists of the following major components:

- Clean Agent Cylinder/Valve Assembly.
- Cylinder Mounting Bracket.
- Firetrace Detector, Actuation and Discharge Fire trace Tubing and Fittings (No Substitute).
- Pressure Switch

3.5 The Clean Agent Automatic Direct System utilizes unique Firetrace flexible tubing that is attached to the top of the cylinder valve. This Fire trace tubing is pressurized with dry nitrogen, is temperature sensitive and acts as a continuous linear thermal detector that ruptures upon Flame impingement. Once the detector tubing is ruptured forming a nozzle at the rupture point, it allows the Clean Agent to flow through, distributing the extinguishing agent into the protected area. Upon system actuation, the pressure switch can be used to indicate system discharge, shutdown ventilation, shut-off electrical power etc may be required.

3.6 The Clean Agent Automatic Direct System is designed and listed as an Automatic unit. No manual or electric means is provided for simultaneous actuation of multiple systems. Only one (1) unit can be used to protect one hazard. These extinguishing units cannot be combined to protect a larger size hazard, since they are not designed to provide for simultaneous actuation of two or more units.

3.7 The Clean Agent is stored in DOT steel cylinders as a liquefied compressed gas, super-pressurized with Dry Nitrogen to 150 psig at 70°F. The ambient operating temperature range for all system components is: +32°F (0°C to 54.4^{o}C).

3.8 Each container is equipped with a nickel–plated brass valve, a pressure gauge to monitor container pressure, and a quarter-turn ball valve that interfaces with the Detection Tubing. The ball valve must be kept closed at all times when the container is not in service. In addition, the container valve is equipped with a pressure relief (rupture disc) device in compliance with DOT requirements.

3.9 A wall-mounted painted steel bracket is used to mount the container/valve assembly in a vertical (upright) position. Each bracket is equipped with two integral quick-clamp straps.

3.10 For the direct Clean Agent systems, the tubing performs three functions: Heat Detection, System Activation, and Clean Agent discharge. The tubing is installed throughout the Electrical Panel volume, with one end connected to the top of the Clean Agent container valve. The tubing is pressurized with Dry Nitrogen to 150 psig and maintains the system in the “OFF” position. An optional pressure gauge or pressure switch can be connected to the other end of the detector/discharge tube to monitor system pressure and/or signal of system actuation, etc. The detector/discharge tubing is heat sensitive and in a fire situation is designed to rupture at any point upon flame impingement. The rupture of the tube results in a formation of a discharge nozzle that will perform a complete discharge of the Clean Agent. Location and spacing of the tubing should be placed above the hazard areas being protected.

3.11 A pressure switch is connected at the end of line of the Detection Tubing to monitor system pressure, system actuation an/or to energize deenergize electrically operated equipment. Manufacturer recommends that all systems use a pressure switch coupled with some other devices to alert personnel in the event of a system discharge.

4.0 DESIGN REQUIREMENTS

4.1 Provide sufficient amount of Clean Agent Novec-1230 liquid to convert into Clean Agent Novec-1230. Considering the following when computing volume to verify suitability and to establish design limitations:

- Volume of hazard area.
- Specific volume of Clean Agent.
- Discharge time and flow rates.
- Design concentration and design factors.
- Detector/discharge tubing placement.

4.2 Locate Clean Agent supply near each hazard area.

4.3 Interface system with main control fire alarm system and BMS (if required).

4.4 Provide total flooding of 4.2 percent Clean Agent concentration by volume as per NFPA-2001.

4.5 The pre-engineered automatic system concept minimizes the amount of engineering required when evaluation is design for a specific application.

4.6 No calculations are required for pressure drop, flow rates or discharge time as long as the discharge/detection tubing is installed within the limits as specified by this manufacturer.

4.7 When the additional limitations of hazard volume, area coverage, maximum height, design concentration, agent quantity, detection tubing arrangement etc are also met, the system installation shall be understood to comply with the design requirements, NFPA-2001, and FMRC approval.

4.8 Therefore, no discharge tests or concentration measurements shall be required.

4.9 All doors and holes in the enclosed/equipment should be closed or sealed to maintain the tightness of enclosure.

4.10 The system should have means to close the exhaust fans if installed in the panel at the time of system activation.

4.11 As desired by the engineer-in-charge the main supply of panel can be shut off with the system.

5.0 DETECTION TUBING

5.1 The automatic system shall become a self-contained, self-actuating unit does not require an external source of power or electricity.

5.2 The system shall utilize unique flexible tubing that shall be attached the top of the container valve. This tubing shall pressurized with Dry Nitrogen to 150 psig at 70°F (1.034 KPA @21°C), is temperature sensitive and shall act as a continuous linear thermal detector that shall rupture upon flame impingement.

5.3 Once the detection tubing is ruptured, forming a nozzle at the rupture point, it shall allow the Clean Agent through the Nozzle into the protected area.

6.0 CLEAN AGENT CONTAINERS

6.1 Design, fabricate, certify and stamp containers in accordance with the requirements of NFPA (DOT). Containers shall be standard model and size of ease of replacement and addition. The containers shall be a part of UL listed or FM approved system.

6.2 Fill containers with required Clean Agent. Pressurize with dry nitrogen to 1,034 kPa (150 psig) at 21 degrees C (70 degrees Fahrenheit).

6.3 Each storage container is equipped with a nickel–plated brass valve, a pressure gauge to monitor container pressure, and a quarter-turn ball valve that interfaces with the detection tubing. The quarter-turn ball valve shall be kept closed at all times when the container is not in service.

6.4 All container valves shall be equipped with a pressure relief valve (rupture disc) device in compliance with DOT requirements.

6.5 The containers shall be located as close as possible to be protected enclosure. In some cases, the containers shall be mounted inside the protected enclosures. The container assemblies shall be located in a ready accessible location to allow for ease of inspection service and maintenance.

6.6 Each container shall be equipped with a straight siphon tube. Each container can only be mounted in a vertical upright position. The container discharge valve shall be capable of releasing the Clean Agent in a vertical direction, so that the discharge force is perpendicular to the floor.

6.7 The pressure gauge shall permit a quick visual inspection of the container pressure.

7.0 MAINTENANCE SERVICE

7.1 Conduct inspections after 3 and 6 months from the Date of Installation & Completion to verify proper operation of system and to check agent container weight and pressure. Include a through check of controls, detection and alarm systems.

7.2 Submit documents, certifying satisfactory conditions. Include manufacturer's certificate of acceptance.

8.0 INSTALLATION

8.1 Install equipment as indicated on the approved shop drawings, and in accordance with requirements of NFPA-70 and NFPA-2001.

8.2 Secure containers as indicated on approved drawings.

8.3 Make final connections between equipment and system detection tubing under direct supervision of factory trained and certified representative of firetrace manufacturer.

9.0 MAINTENANCE OF CLEAN AGENT DIRECT FLOODING SYSTEM

9.1 Clean Agent container/valve assemblies must be handled, installed, inspected and serviced only by qualified and trained personnel in accordance with the instructions contained in the operation manual, the container name-place, NFPA-2201 and any other regulations and codes in jurisdiction.

9.2 Prior to performing maintenance or refilling procedures, it is necessary to refer to the material safety data sheets.

9.3 A regular program of systematic maintenance shall be established for continuous, proper operation of all Clean Agent systems and to avoid violating the warranty.

9.4 A periodic maintenance schedule shall be followed and an inspection log shall be maintained for ready reference.

9.5 The maintenance log shall record the following:

- Inspection Interval
- Inspection Procedure Performed
- Maintenance Performed, if any as a result of Inspection
- Name of Inspection performing Task

9.6 Visually check all components for evidence of physical abuse, corrosion or other damages. Take corrective action by replacing the component, if in doubt, of its ability to perform property.

9.7 Detection / Discharge tubing in the hazard area shall be inspected for abrasion, distortion, cuts, or dirt accumulation, and that there shall be no obstructions preventing the tubing from sensing a fire should one occur.

9.8 On monthly basis, check the pressure gauge of each agent storage container. Normal pressure gauge reading shall be 150 psig at 70°F. Any container that shows a loss in pressure of more than 10% (adjusted for temperature) shall be refilled or replaced.

9.9 Check for proper performance of interlock to shut-down process, ventilating equipment, auxiliary devices and supplementary components such as switches, door and window releases, inter-connected valves, damper releases and supplementary alarms. They should be operated by simulating a fire condition to ensure that they are in proper working order.

9.10 Verify that there has been no changes in the size of the enclosure and that no new ventilation has been added.

9.11 On quarterly basis, check the pressure gauge of each agent storage container and weigh containers to determine agent loss.

9.12 The container shall be removed from the installations as follows:-

- Close the ball valve to the “OFF” position.
- Disconnect the detection / discharge tubing at the ball valve. Note: There shall be a loss of nitrogen pressure out of the tubing.
- Remove the container from the bracket.

9.13 Weigh the container. Compare measured weight with weight found on the container nameplate. If the container shows a loss in agent quantity of more than 5 percent, or a loss in pressure (adjusted for temperature) of more than 10 percent, the container shall be refilled or replaced.

9.14 Reinstall the container and re-pressurize the detection / discharge tubing with nitrogen.

9.15 On every 5 yearly basis, perform external visual inspection of the agent storage containers which have been continuously in service without discharging.

END SECTION – 7
GAS FLOODING SYSTEM

SECTION – 8 ELECTRICAL INSTALLATIONS

1.0 SCOPE

The scope of work shall include supply , storing, unpacking, fixing of all items associated with electrical equipment such as Motors, Motor Control Centers, Starters Cables, interlocks etc. as required.

2.0 APPLICABLE CODES

All applicable codes, standards and statutory regulations shall be used for design and constructions. In general all equipment materials as well as construction shall be in accordance with the latest issues of Indian Standards currently in force and Installation conforming to IE Rules.

3.0 ELECTRICAL SUPPLY SYSTEM

All equipment shall be suitable to following electrical supply parameters:

Voltage	415 V
Phase	3
Wire	4 Wire System
Hz	50
Grounding	Solid
Variation	5% in either voltage or in frequency or in both.

4.0 EQUIPMENT AND MATERIAL

All equipment shall be as per the specifications and drawings and shall be rated to site conditions.

5.0 APPROVAL

The Contractor shall be responsible for obtaining the approval of Drawings and material from Client's Representative.

6.0 ELECTRICAL MOTORS

Rating and Duty:

a) Motor rating shall be as indicated in the Technical Specifications. Any variation shall be clearly pointed out to Client's Representative and necessary approval to be taken before any installation work is carried out.

b) All Motors shall be rated for continuous duty at maximum output.

c) All Motors to be rated for electrical supply parameter as indicated elsewhere in this document.

Design Features:

a) Motor body shall be of close grained cast iron construction and shall be provided with lifting hook. The Motor along with the fan and half coupling shall be dynamically balanced.

b) Fan provided for fan cooled motor shall be non directional type.

Enclosure/Protections:

a) Enclosures for motors shall be totally enclosed fan cooled (TEFC) unless otherwise indicated-SPDP motors shall be used only where desired output is not obtainable in a TEFC frame.

b) Degree of protection shall be IP44 as per IS 4901 and outdoor motor shall be TEFC weather proof type.

c) All motor frame shall have two earth terminals.

Bearings:

All bearings shall have ball and/or roller bearings with limit lubricators.

Insulation:

a) All motors shall have insulation as specified in specifications and Bill of Quantities sections unless the ambient temperature or other conditions necessitated another class of insulation.

b) All materials used in the construction of motors shall be non-hydroscopic.

Painting:

All motors shall be painted in an approved manner using two priming coats and two finish coats. The final colour shall be to the approval of Client's Representative.

Tests:

a) Routine tests shall be carried out on all motors as per IS 325 at manufacturer's work. Test Certificates shall be furnished for all motors before dispatch of motors to site.

b) Owner reserve the right to witness the tests.

Performance Particulars:

Following performance particulars for all motors to be furnished by Contractor before finalizing the orders for motors.

a) Make
b) Type
c) Enclosure
d) Class of Insulation
e) Temperature rise above 40 degree C
f) Rated Output
g) Speed
h) No load current
i) Full load current
j) Locked rotor current
k) Starting Torque
l) Efficiency at full load,3/4 load,1/2 load.
m) Power factor at full load,3/4 load, 1/2 load.
n) Rotor current at rated output
o) Rotor resistance for different torque values
p) Cable terminal size.

7.0 CONTROL STATIONS

Control stations shall be of cast iron or cast aluminium enclosures, consisting of 'START' and 'STOP' push buttons shall have stay put feature of twist unlock type.

8.0 CABLE AND ACCESSORIES

All cables shall be heavy duty insulated armoured and PVC sheathed of 1.1 kV grade. Aluminium conductor cables shall be used for power and copper cables shall be used for control wiring. Glands used shall be compression type.

9.0 OTHER MATERIAL

a) Structural Material:

This shall include MS angles channels, flats, etc required for fabrication of cable trays, local supports for cables control station etc. All steel sections shall be new and conform to IS 226.

b) Conduits:

Shall be GGI heavy gauge/black enameled with prior approval.

c) Earthing:

Shall be either copper strips or wires of suitable sections used for earthing as per IS 3043. All 3 phase 415 v equipments shall be earthed at two points and single phase at one point.

10.0 DRAWINGS

Contractor shall submit 3 sets of control of schematic wiring diagram for all plumbing equipment showing all protections and interlocking for approval before starting of installation or ordering work.

11.0 INSTALLATION AND PAINTING

a) Motor Control Center shall be installed on welded construction channel frame work. Frame work shall be properly grouted by means of foundation bolts or anchor fasteners.

b) All metal work and metal parts shall be cleaned to remove rust, scale, grease or any other matter. Suitable anti corrosion treatment such as phosphatizing shall be given in he metal work. All exposed surfaces of the metal work shall then be given a priming coat of zink chromate or equivalent and finished with two coats of paint of approved shade.

12.0 TESTING AND COMMISSIONING

a) Check tripping and closing of circuit breakers of its protective relays by manual and through control circuit.

b) Check mechanical operation of closing and tripping devices.

c) Check lockout conditions for closing of circuit breakers by stimulating the required conditions.

d) Check control, indications, sequence interlocks and alarm.

e) Check Polarity and connections of instrument transformers.

f) Check CT AND PT connections for its correctness and continuity.

g) Check operation of instruments, meters, relays.

h) Check continuity of power circuits and earth continuity of all non current carrying metallic parts with a low voltage (6V or less) continuity tester.

i) Check insulation of power cables through Megger.

j) Check all equipment for their satisfactory operation and correct wiring.

6.13 OPERATION TEST

a) After successful completion of the above tests operational tests shall be carried out by Contractor for checking the connection done by him and satisfactory operation of all the equipment supplied by him. This test shall be carried out initially without energizing the power circuits.

b) Various control conditions shall be stimulated for the purpose of energized conditions. Any defects deducted during the tests such as blown of fuses damage to circuit breaker or to device shall be rectified by Contractor free of cost.

END SECTION – 8
ELECTRICAL INSTALLATION

ANNEXURE-A **LIST OF APPROVED VENDORS FOR FIRE FIGHTING WORKS**

Contractor shall use the material of approved make as indicated below unless specified otherwise in BOQ or as approved by the Employer's representative.

The Contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, Employer's representative/engineer reserve the right to opt for best preferred listed make.

The Contractor shall quote the rate for material and equipment as per the list of approved makes. In the event of the Contractor wants to use alternate makes other than those stipulated for any reason, the Contractor can send a proposal after ensuring that what he proposes at the least meets both the quality, and safety standard of the stipulated makes, and the financial benefit that will accrue to the Employer. He shall also stand fully guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the employer, whose decision will be final in the matter.

S.NO.	DESRIPTION	MAKE
1	PUMPS	KIRLOSKAR / MATHER & PLATT
2	MOTORS	KIRLOSKAR / ABB / SIEMENS / NGEF / GEC / ALSTHOM / JYOTHI / CROMPTON GREAVES
3	DIESEL ENGINE	KIRLOSKAR/ CUMMINS / RUSTON / MWM / KOEL / KOEHLER / ASHOK LEYLAND
4	STARTERS, SWITCHES / SWITCH FUSE UNITS	AS PER ELECTRICAL LIST
5	VOLTMETER & AMMETER	AS PER ELECTRICAL LIST
6	PRESSURE SWITCH	INDFOSS / SWITZER / MORLEY / SYSTEM SENSOR
7	PRESSURE GAUGE	FIEBIG / H.GURU / NEWAGE / SUKAN / WAAREE
8	PIPES (MS & GI)	TATA / JINDAL HISSAR
9	FITTINGS	
	a) MS / GI FORGED STEEL FITTINGS	VS / GURU / B&M / EQUIVALENT
	B) MS / GI BUTT WELDED ERW FITTINGS	DECCAN METAL / EQUIVALENT
10	SLUICE VALVE	KIRLOSKAR / ZOLOTO
11	GUNMETAL VALVES (FULL WAY &	

	CHECK VALVES) UPTO 65MM DIA	
	a) CLASS I	ZOLOTO / LEADER
	b) CLASS II	LEADER / SANT
12	NON-RETURN VALVES	KIRLOSKAR /ZOLOTO/LEADER
13	BUTTERFLY VALVE	AUDCO /ZOLOTO
14	HYDRANT VALVE	NEWAGE / MINIMAX
15	HOSE REEL TUBE (Thermoplastic synthetic reinforced)	NEWAGE/ KESARA PLAST / SYNTEX
16	HOSE PIPE (RRL TYPE)	JAYASHREE / NEWAGE / CRC / JYOTI / MARUTI / DUNLOP / MINIMAX / SAFEX / ZENITH /SUPEREX
17	BRANCHPIPE WITH NOZZLE	NEWAGE / SAFEGUARD /MINIMAX
18	HOSE BOX	REPUTED MAKE AS PER IS SPECIFICATION SUBJECT TO DMRC APPROVAL
19	PAINTS FOR EXPOSED PIPES	ASIAN PAINTS / BERGER / SHALIMAR
20	ANCHOR FASTENERS	HILTI / HI-TECH SUPPORTS / FISHER
21	WRAPING & COATING MATERIALS FOR UNDER GROUND PIPES	I W L (PYPKOTE) / EQUIVALENT
22	PRIMER / PAINTS FOR PAINTING for ABOVE GROUND PIPES	SHALIMAR BITUMANSTIC PAINTS / EQUI.
23	Y-TYPE / SUCTION STRAINER	KIRLOSKAR / ZOLOTO/ LEADER
24	FOOT VALVE WITH STRAINER	KIRLOSKAR / LEADER / ZOLOTO / SARKAR
25	SPRINKLERS	TYCO / SPRAYSAFE (UK) / RELIABLE (USA) / GRINNEL / STAR
26	ALARM VALVE (INSTALLATION VALVE)	HD FIRE / MATHER & PLATT / SPRAYSAFE/CENTRAL
27	WATER MOTOR GONG & TRIMS	HD FIRE / MATHER & PLATT / SPRAYSAFE / CENTRAL
28	FLOW SWITCHES	SWITZER / FORBES MARSHALL / VIKING / GEM / MACDONALD / GRINNEL / SYSTEM SENSOR / MORLAY IAS

29	AIR RELEASE VALVE	NEWAGE/ KIRLOSKAR
30	PHOTOLUMINESCENT SAFETY SIGNAGES	GLO-LITE / AUTO GLO
31	BATTERIES (MAINTENANCE FREE -VRLA TYPE)	EXIDE / AMCO-YUASA / STANDARD / HBL KNIFE / AMAR RAJA / FURUKAWA
32	BATTERY CHARGER	AS PER ELECTRICAL LIST
33	BALL VALVE	TBS / IBP
34	WATER LEVEL INDICATORS / WATER LEVEL CONTROLLER	ADVANCE / TEKNICA
35	CAST IRON NON- RETURN VALVE DOUBLE FLANGED	KIRLOSKAR/ LEADER
36	RUBBER GASKET	REPUTED MAKE AS PER IS SPECIFICATION SUBJECT TO DMRC APPROVAL
37	SOLAR HEATING SYSTEM	KOTAK/ TATA BP/ EMVEE
38	CO2 Gas Fire Trace Tube System	SOUTHERN ELECTRONIC / EQUIVALENT
39	FIRE SEALENT MATERIAL	3M / FIRE MASTER (MMTCL) / PROMAT / HILTI
40	Portable Fire Extinguisher	Minimax/Nitin/SUPEREX/Zenith/EVERSAFE
41	Welding Electrode	Advani Oerlikan/L&T

10.0 TECHNICAL DATA SHEET OF EQUIPMENTS

10.1 TECHNICAL DATA SHEET	
EQUIPMENT: – 1# HYDRANT PUMP FUNCTION: TYPE: CAPACITY: TOTAL HEAD (mWG) : a) Discharge lift : b) Suction lift : c) Friction : d) Terminal pressure : e) Others Total Head NPSH AVAILABLE: NO. DELIVERY HEAD (mWG): CASING PRESSURE (mWG): MIN. EFFICIENCY (%): MAXIMUM SPEED (rpm):	LOCATION: FLUID TO BE HANDLED: SPECIFIC GRAVITY: VISCOSITY: SOLIDS PRESENT: TEMPERATURE:
CONSTRUCTION	DRIVE
CASING: IMPELLER: SHAFT: SEAL: INTERNALS:	MOTOR IP (KW) TYPE: ENCLOSURE: DUTY: SPEED (RPM): STARTER: ELECTRIC SUPPLY:
STARTER:	

10.2 TECHNICAL DATA SHEET

EQUIPMENT: 1# SPRINKLER PUMP FUNCTION: TYPE: CAPACITY: TOTAL HEAD (mWG): a) Discharge lift: b) Suction lift: c) Friction: d) Terminal pressure: e) Others Total Head NPSH AVAILABLE: NO. DELIVERY HEAD (mWG): CASING PRESSURE (mWG): MIN. EFFICIENCY (%): MAXIMUM SPEED (rpm):	LOCATION: FLUID TO BE HANDLED: SPECIFIC GRAVITY: VISCOSITY: SOLIDS PRESENT: TEMPERATURE:
CONSTRUCTION	DRIVE
CASING: IMPELLER: SHAFT: SEAL: INTERNALS:	MOTOR IP (KW) TYPE: ENCLOSURE: DUTY: SPEED (RPM): STARTER: ELECTRIC SUPPLY:
STARTER:	

10.3 TECHNICAL DATA SHEET

EQUIPMENT: 1# DIESEL PUMP FUNCTION: TYPE: CAPACITY: TOTAL HEAD (mWG): a) Discharge lift: b) Suction lift: c) Friction: d) Terminal pressure: e) Others Total Head NPSH AVAILABLE: NO. DELIVERY HEAD (mWG): CASING PRESSURE (mWG): MIN. EFFICIENCY (%): MAXIMUM SPEED (rpm):	LOCATION: FLUID TO BE HANDLED: SPECIFIC GRAVITY: VISCOSITY: SOLIDS PRESENT: TEMPERATURE:
CONSTRUCTION	DRIVE
CASING: IMPELLER: SHAFT: SEAL: INTERNALS:	MOTOR IP (KW) TYPE: ENCLOSURE: DUTY: SPEED (RPM): STARTER: ELECTRIC SUPPLY:
STARTER:	

10.4 TECHNICAL DATA SHEET	
EQUIPMENT: # JOCKEY PUMP FUNCTION: TYPE: CAPACITY (lpm): TOTAL HEAD (mWG): a) Discharge lift: b) Suction lift: c) Friction: d) Terminal pressure: e) Others Total NPSH AVAILABLE: NO. DELIVERY HEAD (mWG): CASING PRESSURE (mWG): MIN. EFFICIENCY (%): MAXIMUM SPEED (rpm):	LOCATION: FLUID TO BE HANDLED: SPECIFIC GRAVITY: VISCOSITY: SOLIDS PRESENT: TEMPERATURE:
CONSTRUCTION	DRIVE
CASING: IMPELLER: SHAFT: SEAL: INTERNALS:	MOTOR IP (KW) TYPE: ENCLOSURE: DUTY: SPEED (RPM): STARTER: ELECTRIC SUPPLY:
STARTER:	

END OF PART
❖EQUIPMENTS TECHNICAL DATA SHEET ❖